RAILWAY ENGINEERING
and Maintenance of Way

Published by the
CRANDALL PUBLISHING COMPANY

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Office of Publication: Security Building
Corner Madison St. and Fifth Ave.
CHICAGO
Telephone, Main 3185.

Eastern Office: Room 714-716, 132 Nassau Street, New York City
Telephone, 3524 Beekman.

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, bridges and buildings.

Communications on any topic suitable to our columns are solicited.

Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 10 cents. Advertising rates given on application to the office, by mail or in person.

In remitting make all checks payable to the Bruce V. Crandall Company.

Papers should reach subscribers by the tenth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent.

Entered as Second-Class Matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

VOL. III CHICAGO, APRIL, 1907 NO. 4

Echoes from the Convention.

THE eighth annual convention of the American Railway Engineering and Maintenance of Way Association was successfully consummated according to program and its work has been recorded as a matter of history. There was a very good attendance and a splendid participation in the discussions of the various reports of which there are seventeen, covering the various branches of railway maintenance. A summary report with abstracts of the various reports appear elsewhere in this issue.

Taking the committee reports in their numerical order the one on roadway is first; it treats particularly on steam shovel work, giving general specification for railway construction and develops a number of methods for such work. An interesting feature of the report is a recommendation for the proper allowance for settlement on shrinkage of new embankments. It recommends such provision both in vertical and horizontal directions 15 per cent for black dirt trestle filling and 5 per cent where the road bed is raised with the black dirt under traffic. This refers undoubtedly to the fact that in the former case the material will be loosely packed as it is dumped into the trestle while in the latter case the material is being packed and tamped by the trains passing over the track.

However, some allowance should have been made for the consistency of the material as this is a vital factor, also the method of grading will affect the density of the fill, for instance an embankment might be built by using teams and scrapers; the traveling of the teams and wagons back and forth will produce a more solid bank than if the dirt is deposited by a steam shovel or other mechanical method; again wet material usually settles much more complete than dry and lumpy material.

The committee on ballasting prescribed a very able report containing ballast cross sections for single and double track for Class A roads, also roadbed sections for Class B and Class C roads, giving sections for crushed rock and slag, gravel cinders and chats, cementing gravel and chert in each case. These sections were adopted by the association and will be embodied in the manual of recommended practice. The discussion of this report developed a rather peculiar motion in reference to the sodding of the slopes when Mr. Baldwin of the Illinois Central R. R. moved that the sod shown on the embankment side only, should be shown in a similar manner on the cut side with the same width of sod line extending to the ditch and up the side of the embankment; this motion after very little discussion was carried.

While we do not wish to criticize the proceeding, it seems that this action was rather hasty in adopting such a radical departure with so little investigation. It may be true that a sodded ditch can give good results in drainage if the grass is kept cropped very close, and that such a ditch will prevent the erosion and slipping of the bank; but we fail to see the advantage of the sodded ditch over the bare ditch as the work keeping the sod in proper condition will more than offset the labor in cleaning the ditch two or three times a year.

The committee on ties presented recommendations as to the size of ties making 7″x8″x8½ ft. standard for first class track, 7″x8″x8 ft. for second class track, and 6″x8″x8 ft. for third class track. It also reported on the design and use of concrete and steel ties and described a number of different patterns of the same.

There is a certain mechanical relation between the gauge of track and length of tie which will give best results, and this obtains when length of tie equals twice the gauge. This for standard gauge would give 9 ft. 5 ins. as the proper length of tie. If this length of tie be adopted it would reduce maintenance of way expenses, as such ties would not work the ballast and distort the subgrade as is done by shorter ties.

This fact should be borne in mind for the manufacture of steel and concrete ties, where true mechanical relations should be aimed at. In view of the present scarcity of tie timber, however, it may be the best policy not to call for a tie longer than 8½ feet.

The committee on rail did not present any report for 1907, and the next committee in order is No. 5, the committee on track whose report was discussed quite vig-

orously and finally recommitted without adopting any of the recommendations. The report of the track committee gives certain specific standards, recommending certain length of switch points for certain number of frogs to which objections were raised because some roads were using different standards. There was also recommended a switch stand for facing point switch, which was objected to on account of the target arrangement conflicting with the work of the committee on signalling and interlocking. Also the length of guard rail and frogs, as given by the committee did not meet the approval of the association. It appeared that the switch work practice on the various roads in the United States is far from being uniform and the attempt of the committee to introduce some sort of uniformity was combatted from the floor, each member defending the practice on his own road. The elevation of the switch rail above the stock rail was quite fully discussed and the information gained that there is at least one road in the country which does not require this nuisance in its split switches, as its locomotives are not permitted to run over the road with guttered tires. This is the New York Central and Hudson River Railroad, and its western outlet, the Lake Shore and Michigan Southern. How nice it would be if all other roads would follow this example; it would decrease the maintenance expense in yards fully fifty per cent.

The building committee presented data on present practice of designing and building locomotive coaling stations; also a review of the report upon round houses and the proper grade from stall to turntable. The report on improved coal hauling plants is very comprehensive and should prove of the utmost value for such roads as have not yet adopted modern methods of storing and distributing coal. The suggestion that sheds be erected over freight car repair tracks is a good one and should be universally adopted.

The committee on wooden bridges and trestles presented specifications for workmanship for the building of structures by contract; also an enumeration of the most common defects of structural timber which is a very good and novel feature and also a nomenclature for the various kinds of structural timbers which is also a very good feature. The discussion of this report was quite interesting and brought out valuable information.

The report on masonry contained revised specifications for stone and concrete masonry, including a progress report on the size of broken stone to be used in concrete. The subject of failures of concrete structures has been assigned to a subcommittee, and a report will be made upon this subject in 1908. Also the subject of waterproofing concrete will then be reported on.

The committee on signs, fences, crossings and cattle guards rendered a very complete report showing types of gates for right of way fences in use on various railways; also plans and section of highway and private road crossings with data for various kinds of fence posts in use, types of safety signals at public highways, a comparison of metal with wooden signs and their relative cost. The report gives a great deal of information and was adopted by the association.

The committee on signalling and interlocking presented a report revising the standard specifications for mechanical interlocking and construction material; they also presented a discussion on the position of the semaphore arm and a review on the operation and maintenance of interlocking plants. The report was fully discussed and the conclusions adopted by the association.

The report of the committee on records, reports and accounts presents a set of blanks to be used for estimating cost of special work, and issuing authority for same. Also a set of standard conventional signs to be used in right of way or other maps. There was little to discuss and the conclusions of the committee were adopted.

The committee on uniform rules and organization presented a report containing a revision of general rules for the government of employes of the maintenance of way department under two subheads, namely rules governing supervisors of track and supervisors of structures. The rules submitted seem very good and were adopted with some minor changes by the association. It is to be hoped that this committee will at a not very distant date compile a set of rules for track and bridge foremen which shall be uniform all through the country, so that if a foreman who has learned railroading in Illinois can step into a similar position in New York or Colorado and be governed by the same rules.

The report on water service is confined practically to information regarding water softening plants as such is very important. It is, however, a subject in regard to which there is comparatively little known, and it will require years of experimentation and research before a great deal of good can be accomplished in this direction.

The committee on iron and steel structures presented a report on the question whether the limit of phosphorus should be changed in steel castings from .08 to .06 per cent and also whether the ultimate tensile strength of structural steel should be increased to 62,000 lbs. per square inch. The report contains very useful information on classification of existing bridges, conditions of loading and possible causes of failures.

The committee on economics of railway location presented a very technical report, replete with mathematical formulæ relating to train resistance and ruling gradients. After citing very satisfactory results from judicious reduction of grades and curvature it recommended that each company conduct its own experiments for train resistance and that the dynamometer method be used for this purpose, the speed should be actually determined to within 1/10 mile per hour, and all tests shou'd be made on tangents.

The exhibits shown on the parlor floor of the Auditorium Hotel formed a very attractive and useful feature of the convention, and the members of the Railway Maintenance of Way Association were seen examining the products of the supply men whenever they had an opportunity between the sessions of the convention. It

has become, however, apparent to everyone interested that the quarters offered by the hotel are inadequate for the requirements of the exhibitors and it is hoped that better arrangements will be made next year in this direction.

Taken as a whole, the convention has been an unqualified success, and has resulted in the dissemination of a great deal of practical knowledge which will make itself felt through the length and breadth of the whole country in improved condition of the Railway Service.

Eighth Annual Convention of the American Railway Engineering and Maintenance of Way Association

THE eighth annual convention of the American Railway Engineering and Maintenance of Way Association was held at the Auditorium in Chicago, March 19 to 21, inclusive, with more than usual attendance.

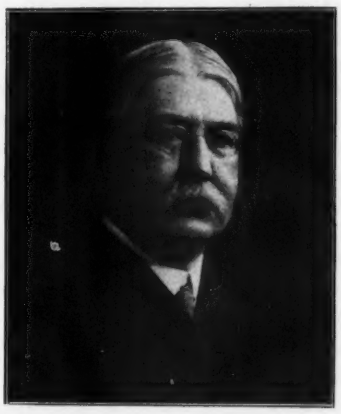
The first session was called to order at 10:25 A. M., on Tuesday, March 19, in the banquet hall of the Auditorium, by president H. G. Kelley, Chief Engineer, Minneapolis & St. Louis and Iowa Central Railroads.

In pursuance of the regular work, the president stated a printed copy of the minutes of last meeting was forwarded to each member for his perusal before the convention. The minutes were approved as printed. The president then read his annual address, in which he referred to a section of the constitution pertaining to the scientific and economical location, construction, operation and maintenance of railroads, and how closely the officers and members have endeavored to live up to that ideal from the beginning of this organization to the present time. Attention was also called to the reports made by the various committees with regard to their arrangement and completeness of the subjects treated. The specifications and data adopted by the association and published with the seal of its approval are looked upon as authoritative standards emphasizes the necessity that the proceedings of this association be marked with care and the most thoughtful consideration; no final action of the association should be taken until every feature of the subject under consideration has been determined.

It was expressed that the new members especially from foreign countries enter into active work of the association by participating with the various committees either in person or by letter so as to give a wider range of knowledge to work upon.

The results obtained from holding joint meetings with members of other associations have been successful in the past year and the opinion was expressed that this practice be propagated.

Particular attention was called to the increasing scarcity of tie timber and some provisions for future supply should receive careful consideration. It is hoped that the softer and more inferior timbers be utilized for ties. as well as other classes of materials. The result of the vote by letter ballot on the amendments to constitution, a copy of which is presented elsewhere in this issue, was then read by the secretary as 190 in favor and 35 against their adoption.



MR. A. W. JOHNSTON, PRESIDENT ELECT.

MR. E. H. FRITCH, SECRETARY.

The treasurer's report for the fiscal year shows a good working balance for carrying on the reseach work proposed.

The chair stated the board of direction had construed the amendments of the constitution concerning membership to be not retroactive and would apply only to future applicants for admission.

A slight gain over last year is shown in the number of members admitted during the past year. At the 1906 convention the secretary's report showed a gain of 65 members as against 74 for the past year.

MEMBERSHIP.

Membership last annual report		528
Members admitted during the year	89	
Withdrawals	3	
Dropped for nonpayment of dues	5	
Deceased	7	
	15	15
Gain		74
Membership date of this report		602

REPORT OF COMMITTEES.

UNIFORM RULES, ORGANIZATION, ETC.

The report of the committee on "Uniform Rules, Organizations, etc.," was read in abstract by Mr. G. H. Webb, chairman. It was desired by Mr. Snow that the rules for supervisors of track be in accordance to instructions suggested for track men in a paper on "A Study of the Stresses in Track Superstructure," by Mr. O. E. Selby, an abstract of which will be found elsewhere in this issue, and also that they be satisfactory to the committee on "Iron and Steel Structures," so they may include them as a part of their recommendations in regard to the maintenance of the different structures. He also states as being a member of the committee on "Iron and Steel Structures," he received a set of rules from the Pennsylvania Lines West of Pittsburg that covered the field well and encouraged something along that line be considered for recommendation by the committee.

The chairman replied the recommended rules are more or less a compilation after a careful study of the rules of several roads. The course pursued was that there is a certain limit to the ordinary trackman's ability to inspect bridges and did not recommend any more than it was reasonable to expect. It was also stated that the committee desire all rules of this nature, not already received, be given to them for further consideration in revising rules for next year.

It was suggested by Mr. McDonald that the committee consider the advisability of having the track supervisor look after swinging ties at the end of structures. This suggestion was seconded by Mr. Cartlidge.

In formulating the report for next year it was suggested by Mr. Hanna some provision be made for recording the flow of water, as well as the high water mark of the various streams and that this information be forwarded to officer in charge at different intervals.

It was moved by Mr. Wendt that the report of this committee be approved and printed in the "Manual of Recommended Practice." This was carried and the committee was commended for producing such a tangible report.

BALLASTING.

In opening discussion on the report of committee on "Ballasting" the chairman, Mr. J. V. Hanna, referred to the paper on "Stresses in Track Superstructure," by Mr. O. E. Selby, and that the conclusions recommended by the committee are the result of following out his line of reasoning.

Sod placed on top of roadbed within twelve inches of the edge of ballast was questioned by Mr. Ewing, with the fear that it would interfere with drainage to some extent. He expressed his desire of cutting off the sod at the top of slope on roadbed section. Mr. Knickerbocker agreed with Mr. Ewing's views and did not believe it advisable to recommend so high a sod line.

Mr. Bush approved of the report made by the committee recommending extended turfing and having had considerable experience in sodding, states of knowing no case where sod held water. It seemed to be the concensus of opinion that the high sod line was preferable and its adoption was moved by Mr. Cushing to appear in the "Manual of Recommended Practice." The motion was carried.

It was thought that a slope of 2 to 1 on stone ballasted or slag roadways a little extravagant and was moved by Mr. Cushing to reduce this slope to 1½ to 1 for both single and double Class A track. Motion carried.

A motion by Mr. Baldwin provided that sod be extended from shoulder of sub-grade down the slope, across ditch and up the embankment. Experience has demonstrated that this practice affords a greater economy in the maintenance of slopes of the cut, as well as the berm of the roadbed, than any other method tried. The fact that it does not interfere with drainage, provided the grass is kept properly cut, was advanced in its favor. This practice was put to vote and adopted. Upon motion by Mr. Wendt the sections for "Gravel, Cinder, Chats, etc.", for classes A and B track was passed as good practice.

Mr. Montzheimer made motion to adopt ballast section for Class C track. Motion carried.

SIGNALING AND INTERLOCKING.

The report of the committee on "Signaling and Interlocking," was the first thing taken up at the second session called to order at 2:20 Tuesday afternoon.

A motion was made by Mr. Raymer to approve and publish the "Standard Specifications for Mechanical Interlocking and Material for Construction Work," in the "Manual of Recommended Practice," and was carried.

Mr. Ewing raised the question if it was not advisable to take the lever as a basis rather than the operated units in the division of expense of operation and maintenance. Mr. Clausen replied it was the tendency on the part of the man who wants to make his proportion of maintenance or operation as small as possible to overload the levers. This may be done by putting the switch and derail on same lever, or two or three bars on one lever, where a separate lever should be used for each operating unit.

Mr. Rhea contended the interlocking expense for operation should be an arbitrary division, based on the number of companies interested and thought it wrong in principle and inequitable in results to divide this expense on the basis of levers or any other operating unit. In this connection the question of prior rights was brought up by Mr. Ewing and thought it unwise to make the older road pay equal share of the operating and maintenance expense.

The change in signaling to make green light clear and yellow for caution is one that is confronting our signal engineers continually. With our present practice if a red light is broken the signal will display white, indicating clear and another unfavorable feature is the difficulty in determining a white light through congested railroad districts. For a long time it was difficult to find a third color that was distinct by night. And now that yellow is proving very satisfactory the question of making this change confronts the convention.

With several examples cited where this practice is used to success it was finally adopted by the convention as good practice.

Mr. Ewing enquired if the upper left hand quadrant had received any consideration by the committee as it is favored by the American Railway Association. In reply for the committee Mr. Rudd said this matter was fully considered but we are timid in recommending it, for the reason when the arm indicates clear the angle to the left would be exactly the same as the angle of the back of an arm for a signal to a train going in the opposite direction.

A suggestion by Mr. Berg provided that the committee be given time to report at another session of this convention precisely what part of the "Manual" should be omitted or revised so as to harmonize with present proceedings.

Mr. Cushing objected to the indication on "take siding at next station," and claimed it unnecessary in a properly arranged system of tracks. The committee as a whole agreed with this, but as there are a number of roads that have not a properly arranged system it was thought best to provide for them.

The innovation of using two lights on every high speed signal was taken up by committee advancing an argument in its favor where one light goes out the engineman has another to stop him. Ordinarily with two lights of full intensity and one disappears, this will indicate the signal is out of order and indicates that train should stop. Conceding that two lights are of advantage the common system may be used by indicating at night two vertical lights for clear, two lights at 45 degree for proceed with caution and two lights horizontal for stop. The latter system is not being recommended, at this time only that it indicated the line of thought confronting the committee and whether the idea of two light system meets the approval of the members.

It was expressed by Mr. Ewing as far as his observations go, the multiplication of lights in busy districts is a bad thing. This was replied to by Mr. Anthony of the committee to the effect that experience has found the two light system better in the congested terminal districts than out on the open road, especially for high speed trains. Mr. Cushing then made motion that committee continue their work and prepare a systematic signal system based on the use of two lights. Motion was carried.

RECORDS, REPORTS AND ACCOUNTS.

An abstract of the report of the committee on "Records, Reports and Accounts" was read by the chairman Mr. E. F. Wendt. The discussion was opened by Mr. Wendt, saying the general purpose of the report is to present a set of forms to be used in connection with estimating cost of work, issuing authority to proceed with work, as well as to recommend certain standard conventional signs. The committee was asked by Mr. McDonald if they based their recommendations on the general practice of different roads?

This was replied to by citing several examples on the various roads, with the assurance that the report is a recapitulation of many submitted. With the exception of a few changes in the form, the report submitted was recommended by the convention as being good practice to be published in the "Manual."

Upon completing the report of this committee the session adjourned until 8 p. m.

ECONOMICS OF RAILWAY LOCATION.

On account of the illness of chairman Mr. W. McNab, the report of the committee on "Economics of Railway Location," was presented by Prof. C. Frank Allen, of the Massachusetts Institute of Technology.

The discussion was opened by Prof. Allen claiming while the report is more or less historical in its character it leads up to matters continually dealt with on railroads.

The committee also asks the co-operation of members in working up data on experiments already made or conduct additional experiments to make the report in the future cover a larger field. Several examples of grade reduction were brought out by Mr. Ewing and others, where the train tonnage was increased nearly one third the original.

Mr. Carothers referred to many dynamometer tests for train resistance run under various conditions that are being made on the Baltimore & Ohio Railroad and would be glad to furnish the committee any information of that kind he may have. As stated by the president the problem confronting the committee is one not only of train resistance but the broad economic feature of location as it will affect the cost of operation and maintenance. With the hope of giving the committee some base to work upon several typical cases were related with the assurance that the committee may obtain further information if desired.

The convention then closed their work for the first day.

BUILDINGS.

The meeting was called to order at 9:45 by President Kelley, Wednesday morning. The report by the committee on "Buildings" was presented by the chairman Mr. A. R. Raymer and the discussion was opened by Mr. Wendt in asking the committee how they divided the interest, depreciation and maintenance of the structures referred to in report. Mr. Coburn replied for the committee, saying the interest was about 5 per cent and the depreciation and maintenance about 10 per cent of original cost. While these figures are more or less approximate it was necessary for the committee to make some assumption to arrive at conclusions.

The question of relative cost in handling lump coal as compared with fine coal was brought up by Mr. Snow. The committee did not discriminate in this matter, knowing the finer coal can be easier handled, but having no figures to base this did not make any discrimination. The qualities of the various types of coaling stations were discussed with a varied difference of opinion in their use and as this is a matter largely controlled by conditions, such as space, number of engines to be coaled, kind of coal, etc., it was thought advisable to let

the individual roads decide according to their practice and conditions.

It was suggested by Mr. Lum that the committee take up the matter of handling ashes in connection with coaling stations to report at a future meeting.

ROADWAY.

At 11:50 the report of the committee on "Roadway," was presented by Mr. G. H. Bremner, in absence of the chairman, H. J. Slifer.

With the exception of a few slight changes in formality, the conclusions recommended by the committee were adopted to appear in the "Manual" as good practice. The session then adjourned until 2 p. m.

IRON AND STEEL STRUCTURES.

The afternoon session commenced with a report of the committee on "Iron and Steel Structures," presented by the chairman Mr. J. P. Snow, who stated the committee is not prepared at this time to recommend the advisability of changing the ultimate strength of steel from 60,000 to 62,000 pounds as well as the reduction of the limit of phosphorus in steel castings from 0.08 to 0.06 per cent.

The subject of making experiments for impact on existing bridges was referred to this committee last year and some progress has been made. The committee recommends the use of an instrument perfected by Professor F. E. Tourneaure of the University of Wisconsin, that has been tried and believed will do the work satisfactorily. The railroads have been asked to contribute to the expense of making these tests and the majority have replied to the affirmative indicating their willingness to stand their portion of the expense on the mileage basis. It is anticipated these experiments be made in the near future, or at least, started this year.

WOODEN BRIDGES AND TRESTLES.

The report of the committee on "Wooden Bridges and Trestles" was presented by Mr. H. S. Jacoby, chairman.

Attention was called that a distinction should be made in specifying the size of hole for square or round drift bolts as in case of a square drift bolt, the bolt hole is generally 1/16 in. larger than bolt. While the round drift bolt is used nearly exclusively it was thought best to make some provisions for the square bolt.

It was suggested by Mr. Montzheimer that the bark on all piles be peeled above the ground. Mr. Reid carried this further by suggesting they be peeled the full length for the reason when put in the ground with bark, the tendency is for the bark to loosen and the pile will slip within the bark.

Mr. Porter moved that all stringers be sized to a uniform height where they rest upon supports, thus affording an equal distribution of the load placed upon the ties. This motion was seconded and carried.

The splicing of each joint of timber guard rails by a half and half splice over a tie was objected to by Mr. Storey, who moved this clause be omitted in conclusions. (Motion carried.)

Prof. W. K. Hatt contented it would be better for the committee to persist in its definition between long leaf and short leaf pine, as being descriptive of quality and not of the species in which case inspection is not so difficult.

Dr. Hermann von Schrenk stated when it came to making distinctions between short leaf and loblolly pines, that it was almost a physical impossibility and preferred classifications to be descriptive of quality.

The definition that all timbers coming from Washington territory are classed under one head was objected to by Mr. Berg, as there is a marked difference in strength between yellow fir and red fir. As there seemed to be several questionable conclusions submitted, the matter was referred to a future meeting.

After the discussion of this report Mr. L. R. Clausen was permitted to report concerning the instructions given on Tuesday to the committee on "Signaling and Interlocking." This report consisted in making one of the conclusions submitted for approval harmonize with the matter already recommended to be printed in the "Manual." This was approved by convention upon motion of Professor Pence.

TIES.

Upon the absence of chairman, Mr. E. B. Cushing, the report of the committee on "Ties" was presented by Mr. W. W. Curtis, vice-chairman, who stated that the committee was burdened with work and as a result the report is not complete and should be treated as progress. It is hoped to be able to put it in tangible shape for next year. The data on concrete and metal ties has been withheld until such time when a more complete report can be given.

An objection was raised by Mr. Lum in reducing the thickness of ties to be used on third-class track to six inches, with the claim if anything the thickness should be increased in keeping with the greater loads to be carried nowadays than in the past.

The committee replied it had considered this very carefully and have asked several railroads if there was any objection to the use of a 6x8-in.-x8-foot tie, with a reply to the negative. This in mind and the fact that several are in use at present, as well as the increasing scarcity of timber the committee based its recommendations.

The roads using the 6 in. ties and a long spike are gradually substituting 7 in. ties for the reason a six-inch tie after using a few years is penetrated through by the long spikes.

Mr. Lum emphasized the necessity of using more ties and spikes as well as additional tamping in case the smaller ties were used with the possible result of costing nearly as much as the larger ties. It would also require more section men in keeping the surface and alinement of track.

The problem of recommending the size of tie to be used is one unsettled by many and means so much to the railroads that it seemed the sense of the convention to pass upon this at a later meeting. A motion by Mr. Berg, asking the committee to consider this for another

year and aim to formulate a conclusion giving the classes and sizes of ties to be used was seconded and carried.

As a matter of information, the chairman asked that the sense of the convention be expressed as to the desirability of recommending any standard size of tie. Mr. Johnston moved this be taken up by letter ballot during the year. The motion was seconded and carried. The session then adjourned until Thursday, at 9 a. m.

THE ANNUAL DINNER.

The eighth annual dinner of the association was held in the banquet hall of the Auditorium on Wednesday evening, March 20. The increased attendance and good-fellowship shown was more in evidence than at any previous dinner and reflected great credit upon the event as well as the committee on arrangements.

The usual custom of after dinner speaking was presided over by President Kelley as toastmaster.

The first speaker was Mr. G. T. Fitzhugh, counsel, Nashville, Chattanooga & St. Louis Railway, who discussed the attitude taken by the public toward railroad corporations. Mr. C. L. Hutchinson, President Corn Exchange National Bank, delivered a lengthy address on interesting observations made by him as a casual observer of the progress made on Panama Canal. In closing Messrs. F. R. Coates and W. A. Smith made short talks.

SIGNS, FENCES, CROSSINGS AND CATTLE GUARDS.

The meeting was called to order by the President, Thursday morning, and the first work was the consideration of the report of the committee on "Signs, Fences, Crossings and Cattle Guards," presented by Mr. W. D. Williams, chairman.

An objection was made by Mr. McDonald on including all forms of automatic crossing alarm bells to be used at crossing where there is a limited amount of travel.

He would restrict them to a particular style so as to avoid the mischief of the small boy in short circuiting bells, etc. He referred to some bad accidents caused by inefficient signaling system, similar to those he wished to avoid. With a few modifications the conclusions of the committee where recommended as good practice.

RAIL.

Mr. H. G. Prout, acting chairman of the committee on "Rail" forwarded by letter the following information to the convention: The committee has continued its investigations into the matter of breaking of rails, and observations of the performance of open hearth rails and feels that it would be immature to express any opinion on either of these subjects and, therefore, begs to report progress.

TRACK.

In the absence of chairman Mr. L. S. Rose, an abstract of the report of the committee on "Track" was read by Mr. T. H. Hickey, vice-chairman. An objection was made by Mr. Clausen that the indication given by the recommended switch stand is a matter of signaling and should be handled by the signaling committee. Also that the type of stand recommended cannot be applied to all switches for the reason that at many points the clearance will not allow of their use.

Mr. Ewing expressed his opinion as being in sympathy with the objections just made and believed the report should be referred back for further considerations.

This was made in form of motion by Mr. Camp including that the committee confer with committee on "Signaling and Interlocking," in formulating conclusions. Motion seconded and carried.

Mr. Bremmer questioned the advisability of this association recommending a 10 ft. switch point, saying it has been his experience that they are not desirable and favored the 16½ ft. switch point. As the members did not care to decide on any particular length of switch point a motion was made to refer this back to the committee with the instructions that they take the matter up by letter ballot with the railroads and switch and frog companies to report its conclusions at a future meeting.

Upon the recommendation that open hearth steel be used in switch points, Mr. G. W. Parsons of the Pennsylvania Steel Co., conceded that the specification for open hearth steel is a little too broad. Some very poor steel might be put into a rail that had been cast from an open hearth ingot. He also contended that it is not sufficient to only specify the open hearth process but should specify the limitations of the deleterious elements as well as the conditions of drop test.

A suggestion was made by Mr. Slifer that the committee consider the matter of adjustable features on track switches in their next report as it is receiving considerable attention at present.

Mr. Ewing questioned the recommendation for the use of manganese steel as the most economical for yard service and made a motion, which was later carried that this be referred back to committee.

The sharp bend on guard rails, as shown on plan, was objected to by Mr. Ewing, claiming it would produce a very bad jar on rolling stock as well as tend to the displacement of the guard rail. He conceded it to be good practice to carry the bend back three feet from the end of rail and taper gradually. This matter was referred back to committee for further consideration.

The committee on "Yards and Terminal," announced their report was under progress and would be presented at the next annual meeting.

The result of letter ballot on the report presented by the special committee on Classification of Track at the 1906 convention. (See Railway Engineering and Maintenance of Way, April, 1906, page 89), was read by the president as 152 in favor and 8 against.

The session then adjourned until 2 p. m.

WATER SERVICE.

The afternoon session opened with the consideration of report of the committee on "Water Service." Mr. A. K. Shurtleff, chairman of committee.

After reading the conclusion, the chairman opened the discussion by saying in the barium hydrate treatment, the reactions of magnesia and calcium sulphates

will produce such finely divided particles in the solution that necessitates a long time to settle, as well as the solution being poisonous.

As trainmen, especially on western lines, are in the habit of drinking this water it could only be used with the greatest precaution.

In describing some experience with water softeners, Mr. Raymer claimed they have gone beyond the experimental stage and are serving their purpose very satisfactorily. He commended the committee on the conclusions recommended and moved their adoption. The motion was carried. Mr. Raymer stated the tendency for boilers to foam or prime is increased by using them irregularly. He also confirmed that 100 grains of foaming solids in locomotive boiler per gallon is a conservative figure and moved its adoption. The motion was carried.

MASONRY.

The report of committee on "Masonry," was presented by chairman Mr. A. O. Cunningham.

The revised specifications recommended were adopted upon motion of Mr. Berg by the convention.

Mr. C. G. Crawford, of the United States Forest Service, addressed the convention for a short time with the hopes of informing its members what the Forest Service Commission is doing to help solve the tie problem.

Experiments are continually being made on different forms of ties both treated and untreated, under various conditions, in determining the merits of each system. The results are public property and are immediately placed at the disposal of the railroads for their use.

The officers and directors of the association for the current year are:

President—A. W. Johnston, N. Y. C. & St. L. Ry., Cleveland, O.

First Vice-President—Walter G. Berg, L. V. R. R., New York, N. Y.

Second Vice-President—Wm. McNab, Grand Trunk Ry. System, Montreal, Can.

Treasurer—W. S. Dawley, Mo. & No. Ark. Ry., St. Louis, Mo.

Secretary—E. H. Fritch, 962 Monadnock, Chicago, Ill.

Past-Presidents—John F. Wallace, Prest. Elec. Prop. Co., New York; Hunter McDonald, N. C. & St. L. Ry., Nashville, Tenn.; George W. Kittredge, N. Y. C. & H. R. R. R., New York.; H. G. Kelley, M. & St. L. Ry., Minneapolis, Minn.

Directors—J. B. Berry, C. R. I. & P. Ry., Chicago, Ill.; C. S. Churchill, N. & W. Ry., Roanoke, Va.; W. C. Cushing, Penna. Lines West, Pittsburg, Pa.; J. P. Snow, B. & M. R. R., Boston, Mass.; W. G. Besler, C. R. R. of N. J., New York, N. Y.; L. C. Fritch, Illinois Central R. R., Chicago.

The retiring and incoming presidents gave brief addresses and a resolution of thanks was voted to the outgoing president as a tribute for excellent service rendered the association The convention closed at 3:30 p. m.

Abstracts of Committee Reports, Railway Engineering and Maintenance of Way Association

Uniform Rules, Organizations, Etc.

Your committee submits as its annual report a revision of the "General Rules Governing Employes of the Maintenance of Way Department," adopted in 1906, with additional rules governing supervisors of track; also, a series of rules governing supervisors of structures. We report progress on the rules governing supervisors of signals, and suggest that this subject be reassigned for the coming year.

It has not seemed advisable for your committee to formulate specific rules for the government of supervisors of track, structures, etc., for the reason that other committees of the association will from time to time make recommendations as to the manner of performing certain work; therefore only general rules have been prepared by this committee.

The second subject assigned by the board of direction, as to the advisability of placing "Water Service" under a separate sub-division, has been carefully considered, and the conclusion reached that it would be preferable for each individual road to determine this question for itself. In cases where this branch of the service is under a separate organization, the general rules pertaining to supervisors of structures can be made applicable with a slight modification.

The third subject assigned by the board of direction—consider the possibility of a general form of contract applicable to all classes of railroad work—has been given due consideration by your committee. We believe it to be advantageous to have a uniform general contract form for all contracts entered into by the engineering department of railroads; however, your committee respectfully suggests that it would more properly come within the province of some other committee of the association to prepare such general contract form.

REVISED RULES GOVERNING SUPERVISORS OF TRACK ADOPTED.

(1) They shall report to and receive instructions from the
(To be filled in by each road.)

.....

(2) They shall be responsible for the safe condition and proper maintenance of track, roadway, right-of-way, station grounds and driveways. They must inform themselves of the condition of structures, make temporary repairs of such defects as may endanger or delay the movement of trains; and promptly
(Title.)
report defective condition to .....

(3) They must frequently pass over their districts, observe the condition of track, roadway, right-of-way, station grounds and driveways, and have necessary repairs made as promptly as the conditions require.

(4) They shall employ, in the discharge of their work, such men as are necessary for carrying out the duties for which they are responsible.

(5) They must know that all foremen are provided with all rules, circulars, forms, and special instructions pertaining to their duties, and that they fully understand and comply with the same.

(6) They must see that all foremen are familiar with the rules in regard to train signals and flagging, and that they fully understand and comply with the same.

(7) They must know that all foremen are supplied with tools and material necessary for the efficient performance of their duties, and must see that they are properly cared for and used.

(8) They shall conform to the prescribed standards and plans in the execution of the work under their charge.

(9) They shall have immediate supervision of all work train service for the maintenance of track on their districts, and employ such service only when authorized by the ....., (Title.) doing work by other means as far as practicable and economical.

(10) They must go promptly to the spot with the force, tools and materials necessary to effect clearance and repairs in cases of obstruction or damage to track or roadbed.

(11) They shall investigate and report on Form No. ..... all accidents occurring in their districts, which may be attributable to or result in damage to track, roadbed or structures.

(12) They shall see that no encroachment upon or occupancy of any portion of the company's right-of-way is permitted, except by authority of the ..... (Title.)

(13) They shall not permit experimental trials of appliances or devices not standard with the Company, nor give out information of the results of any trial, except by proper authority.

(14) They shall keep general oversight of all work performed in their district by contractors or others who do not come under their direct charge, and see that nothing is done by them that will interfere with the safety of track or movement of trains.

(15) They shall see that all openings for the passage of water and their approaches and outlets are kept free from brush, driftwood, etc.

(16) They shall see that the vicinity of bridges and trestles are cleared of all combustible matter, such as chips, bark, dried grass, etc.; and that bridge seats, tops of piers and bottom chords are kept cleaned of cinders and dirt, and that necessary water barrels at timber bridges and trestles are filled with water.

RULES GOVERNING SUPERVISORS OF STRUCTURES.

(1) They shall report to and receive instructions from the (To be filled in by each road.)

.....

(2) They shall be responsible for the safe condition and proper maintenance of the structures on their districts. They must inform themselves of the condition of structures, make temporary repairs of such defects as may endanger or delay the movement of trains, and promptly report defective condition to (Title.)

.....

(3) They shall employ, in the discharge of their work, such men as are necessary for carrying out the duties for which they are responsible.

(4) They must know that all foremen are provided with all rules, circulars, forms, and special instructions pertaining to their duties and that they fully understand and comply with the same.

(5) They must see that all foremen are familiar with the rules in regard to train signals and flagging, and that they fully understand and comply with the same.

(6) They must know that all foremen are supplied with tools and material necessary for the efficient performance of their duties and must see that they are properly cared for and used.

(7) They shall conform to the prescribed standards and plans in the execution of the work under their charge.

(8) They shall have immediate supervision of all work train service for the maintenance of structures on their districts, and employ such service only when authorized by the ..... (Title.) ....., doing work by other means as far as practicable and economical.

(9) They will go promptly to the spot with the force, tools and materials necessary to effect clearance and repairs, in cases of obstruction or damage to structures.

(10) They must make frequent inspections of all structures on their districts and have necessary repairs made as promptly as conditions require.

(11) They shall make from time to time observations of the flow of water of the various streams passing under the track, so as to determine whether sufficient waterway is provided by the present structure, and tabulate this information for future reference.

Your committee recommends the approval of the revised Rules Governing Supervisors of Track, and the adoption of the Rules Governing Supervisors of Structures.

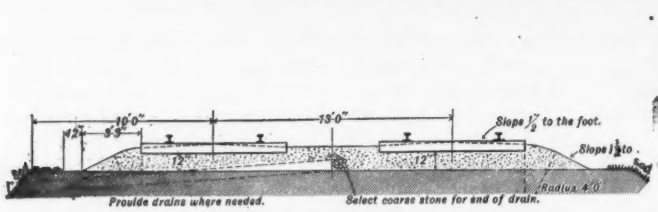
Ballasting

After several meetings during the year the members of the committee on "Ballasting" were able to agree on sections in 1905, submitting a minority, as well as a majority, report. The sections submitted in 1906 (See Railway Engineering and Maintenance of Way, April, 1906, page 66) were the result of an effort to get together and were in the nature of a compromise. They were not adopted by the convention, but were referred back to the committee for revision. Motions were passed by the convention cutting out the crown in the roadbed, shown on the committee's sections; instructing the committee to make a cross-section suitable for stone or slag ballast as well as gravel, and to omit the projection above top of tie, shown on one of the gravel sections, bringing it, instead, flush with top of tie at center.

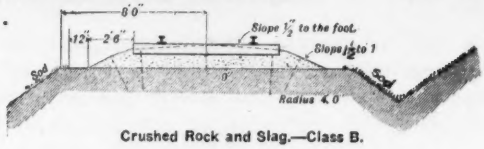
Following these instructions and the suggestions made in the convention as to slope of stone and slag ballast, the committee has prepared a new set of sections, which are herewith submitted. At the meeting held November 12th the proofs of the paper by Mr. O. E. Selby on "Study of the Stresses Existing in Track Superstructure and Rational Design based thereon" (see Bulletin No. 80) were placed before the members present and the meeting of December 10th was principally for the purpose of discussing the points brought out in that paper and their bearing on the ballast sections. It was the sense of that meeting that the depth of ballast on sections shown for class A track should be considered a minimum and held to apply only where the sub-grade was well drained, and of the firmest and most substantial character. It was thought that other sections should be prepared showing the requirements for sub-grades with small supporting power, but as it was necessary, in order to get consideration by the convention, to have the report ready for early printing in the bulletin, it was thought best not to attempt to get out those sections now, but to do so later, when there had been an opportunity for discussion by the convention.

In the joint conferences with the "Tie and Track" committees it was concluded not to make any changes in the drawings on account of difference in length of ties, as the sections as shown could practically be applied with any length of tie. Figures for the length of tie were therefore purposely omitted.

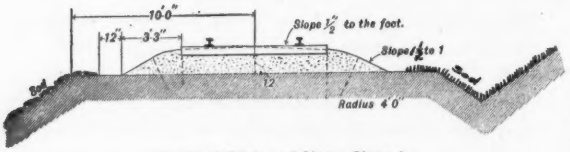
With regard to the effect of ballast sections on roadway, those for gravel, cinders, chats, etc., classes B and C, show a very narrow margin between the foot of the ballast and the shoulder of the bank. This brings up the question of whether or not a wider roadway would not be advisable for these two classes. In the joint meeting it was concluded not to make any definite recommendations at this time, but, instead, to suggest a further inquiry as to whether the present classifications sufficiently met the requirements. In this line a little consideration of Mr. Selby's paper will show that for soils requiring a small unit bearing stress, particularly with gravel and similar ballasts, the necessary area cannot be obtained on a 20-foot roadway. It was the opinion of the members of the various committees who attended these joint meetings that Mr. Selby's analysis was



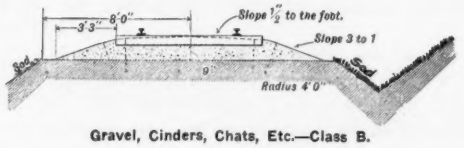
Crushed Rock and Slag.—Class A.



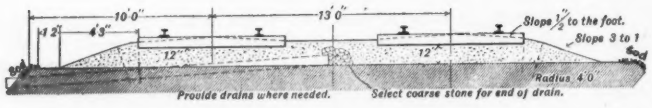
Crushed Rock and Slag.—Class B.



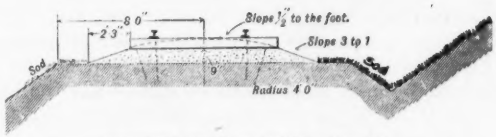
Crushed Rock and Slag.—Class A.



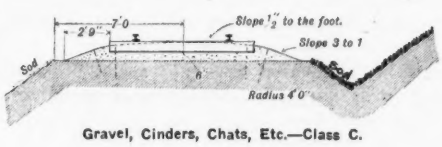
Gravel, Cinders, Chats, Etc.—Class B.



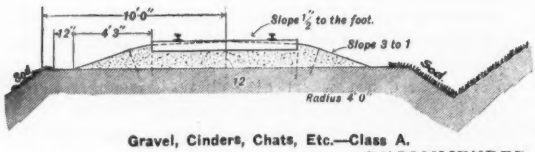
Gravel, Cinders, Chats, Etc.—Class A.



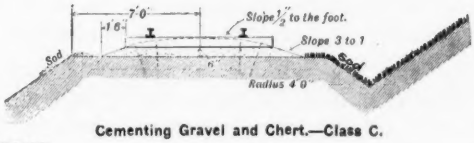
Cementing Gravel and Chert.—Class B.



Gravel, Cinders, Chats, Etc.—Class C.



Gravel, Cinders, Chats, Etc.—Class A.



Cementing Gravel and Chert.—Class C.

RECOMMENDED SECTIONS.

SECTIONS FOR CLASS A TRACK ARE RECOMMENDED FOR USE ONLY ON THE FIRMEST, MOST SUBSTANTIAL AND WELL DRAINED SUBGRADE.

along the right line, although no attempt was made to follow it to a conclusion with soils of different supporting capacities. This the committee would like to do in a future report.

The committee obtained a list of articles on the subject of ballasting, which is submitted with this report, from the secretary of the American Society of Civil Engineers with the intention of following the instructions of the board of direction to make a study of special literature on the subject of ballasting. No member of the committee has been able to read this matter and any study of it must be reserved for a future report.

Your committee would call attention particularly to the discussion on the 1906 report appearing in Vol. 7 of the Proceedings, submitted in writing by W. C. Cushing of the Pennsylvania Lines West. The committee considers this a valuable addition to the general knowledge of the subject.

Your committee recommends that the ballast sections submitted be approved as good practice.

Signaling and Interlocking

The committee has carefully considered the matter of placing the indications in the upper right hand quadrant and has ascertained that the consensus of opinion among Signal Engineers and operating officials familiar with signal conditions is that this type of signal be adopted for these reasons, viz.:

(1) The signal indications thus given concur more nearly with customary standard hand and lamp signals than the present signal indications in the lower right hand quadrant.

(2) The signal construction is more perfect mechanically, as any extraordinary weight, such as snow and ice, on the signal blade tends to place signal in stop position.

(3) There should be a slight reduction in the cost of maintenance and operation, particularly in block signals, owing to reduced motive power necessary for operation.

The committee was given an opportunity of inspecting the first installation of automatic block signals with the upwardly inclined arm, or in the upper right hand quadrant, on the Media branch of the Pennsylvania Railroad, near Philadelphia, and the consensus of opinion of the committee was that this system was the proper system to be adopted. In this connection, the committee submitted to a joint committee of the Railway Signal Association diagrams showing an ideal signal system, with the indications in the upper right hand quadrant, which association adopted the conclusions (shown in paragraphs a, b and c, submitted herewith) and passed the following resolutions:

"That it is the sense of the association that the submitted methods of displaying the signal indications have advantages over other methods now in general use."

The committee submits the three conclusions (a, b, c), adopted by the Railway Signal Association, for adoption by this association, and submits the balance of this report as a progress report, and desires your further instructions. Therefore the committee recommends:

(1) That the following indications be considered as those which are required in a complete system of signals:

INDICATIONS—RESTRICTING RIGHTS.

1. Stop at or before reaching, and stay.
2. Stop at or before reaching, and proceed cautiously.
3. Prepare to stop at next signal.
4. Proceed under control, block is occupied.
5. Take siding at next station.
6. Proceed on high speed route, prepared to stop at next signal.

7. Proceed on limited speed route, prepared to stop at next signal.
8. Proceed on slow speed route, prepared to stop at next signal.

INDICATIONS—CONFERRING RIGHTS.

9. Proceed, block is clear.
10. Proceed, block clear and next signal at proceed.
11. Proceed on high speed route, next signal at proceed.
12. Proceed on limited speed route, next signal at proceed.
13. Proceed on slow speed route, next signal at proceed.

INDICATIONS—CONVEYING INFORMATION.

14. Switch open, main, siding.
15. Switch closed, main, siding.
16. Home switch indicator denotes open switch.
17. Home switch indicator denotes closed switch
18. Stop for passengers.
19. Need not stop for passengers.
20. Track tank, entrance end.
21. Track tank, exit end.
22. Get orders.
23. Reduce speed. (Track sign.)
24. Resume speed. (Track sign.)

(2) That the following principles of giving indications govern in formulating a system:

(a) On all signals conferring or restricting rights, a red light shall be the night indication for stop. A yellow light shall be the night indication for caution*, and a green light the night indication for clear.

*The word caution to be used as indicating the function of a distant signal.

(b) That the day indications of semaphore signals be given in the upper right hand quadrant.

(c) That the semaphore arm horizontal shall indicate stop; inclined upward 45 degrees, caution; and inclined upward 90 degrees, proceed.

(d) That two lights shall be displayed on every high speed signal.

(e) That the stop indication shall be given by red lights in a vertical line.

(f) That the stop and proceed indication shall be given by red lights in an oblique line.

(g) That lights in a horizontal line shall be used for information signals.

(h) That automatic home block signals shall have one arm with end pointed.

(i) That interlocking home signals shall always have two full-sized arms representing unlimited, and limited or medium speeds, and shall have one low speed arm, distinguished by a greater interval between it and the second arm, than the interval between the top and second arm, and by a dim light at night, when such low speed arm is required. The arms to have square ends.

(j) That the stop indication of dwarf signals shall be given by a purple light.

(k) That the home signal shall be displayed in the 45-degree position to indicate that the advance signal is at stop.

(l) That interlocking distant signals shall be provided with two arms.

(3) Diagrams illustrate the aspects recommended by your committee to give a part of these indications.

(4) On account of the limited time at the disposal of the committee, it did not complete the work of providing all the aspects required. The types to be used for telegraphic, block and train-order signals, for the indication "Take siding at next station," and for distant signals approaching an interlocking, not in automatic block limits; the colors of lights on high switch indicators, and the various forms of other information signals, were not decided on.

The subject of operation and maintenance of joint interlocking plants has been gone into thoroughly by the committee, and in connection with this a universal form of contract for crossings and the division of expenses of installation, renewal and maintenance has been formulated and discussed at the committee meetings, but the committee has not been able to recommend the exact type of the form, and requests that this be considerd in the nature of progress report. The committee has agreed that the best method of the division of expense at joint interlocking plants should be made on the basis of the number of operated units, and the committee recommends that this be adopted by the association according to the following:

One signal arm; one pair switch points; one derail; one pair movable point frogs; one 50 foot detector bar, with or without lock; one scotch block; one torpedo machine; one power signal; one for each electric lock; annunciator and indicator; one route.

The general purpose of the present report, in accordance with instructions from the board of direction, is to present a set of forms to be used in connection with estimating cost of work and issuing authority to proceed therewith, and to present certain recommended standard conventional signs to be used in connection with right-of-way and topographical maps.

The committee has held six meetings during the year, and the attendance was highly satisfactory. Careful study has been given to the subjects in question, and the conclusions represent the combined judgment of the membership of the committee.

CONCLUSIONS.

Your committee begs to submit the following conclusions for consideration of the association:

(1) That the specifications for mechanical interlocking, submitted, which have been adopted by the Railway Signal Association, be adopted by this association.

(2) That the following principles of giving indications in a signal system be adopted:

(a) On all signals conferring or restricting rights, a red light shall be the night indication for stop; a yellow light shall be the night indication for caution, and a green light the night indication for clear.

(b) That the day indications of semaphore signals be given in the upper right hand quadrant.

(c) That the semaphore arm horizontal shall indicate stop; inclined upward 45 degrees, caution; and inclined upward 90 degrees, proceed.

(3) That the division of expense of the operation and maintenance of interlocking plants be divided on a unit basis, and that the association adopt the division of this basis according to the table submitted by the committee.

(4) That the executive committee of the association be requested to take up the question with the executive committee of the American Railway Association of bringing about a joint meeting of the signaling committees of the two associations.

GENERAL REQUIREMENTS.

1. Except as modified by plans or specifications furnished with request for tender, the contractor shall base his bid on the conditions existing at the time of such request.

2. The contractor shall furnish all tools, material and labor, except as may be hereinafter noted, to erect and complete the work in accordance with the intent of the plans and specifications, and anything that is obviously necessary to complete or make useful any part mentioned in specifications shall be provided by the contractor, although such part is not shown by the plans.

3. The company will furnish in place all switches, derails, movable point frogs and ties for same, including ties for bolt locks and crossing bars, and will do all necessary draining, grading and blasting; also provide space for connections and any necessary municipal, state or other government permits.

4. The contractor shall frame all ties for switches, derails, movable point frogs, bolt locks and crossing bars, and do all drilling for interlocking connections.

5. All material shall be furnished f. o. b. cars on the company's lines of railway.

6. Immediately on completion of the work the contractor shall remove and dispose of all refuse made by his men and leave the buildings in condition for occupancy.

7. All threads shall be U. S. standard as far as practicable.

8. All parts shall be properly proportioned for strength, and all materials and workmanship shall be of the best quality.

9. All plans furnished by the company at the time of signing the contract shall be considered a part of these specifications.

10. The contractor shall furnish the company two sets of working drawings for use during the construction, and before final payments are made shall furnish each company interested such vandyke or similar prints of general installation plans, as may be required, showing the work as installed.

11. The best practice at the time the work is performed will govern in all particulars not mentioned in these specifications, and if any devices are furnished which have not been in general use they shall be subject to acceptance of the (Title) .....before being placed in position.

12. The contractor shall not deviate from these specifications, except on written permission from the company, and no bills for extra work will be allowed unless such work shall have been ordered in writing.

SPECIFICATIONS FOR MECHANICAL INTERLOCKING.

INTERLOCKING STATION.

20. Interlocking station must be built in accordance with the plans approved by the company.

INTERLOCKING MACHINE.

26. The machine must be of the preliminary latch-locking type, rigidly supported on a wood or steel frame, as required by the company, and like parts of the same type of machine shall be interchangeable as far as practicable.

27. One bracket for tappet or locking, one lever shoe pin and one locking bar extending the entire length of the machine shall be provided for each spare lever space.

28. All the levers in a machine shall have equal and uniform throw. Tail levers for pipe connections shall be drilled to provide for 8¾ inches, 9¾ inches and 10¾ inches, movement of pipe line. Tail levers for wire connections shall be drilled to provide for 10¾ inches, 14¾ inches, 16¾ inches and 18¾ inches movement of wire line.

LEADOUT.

38. Deflecting stand, crank or rocker shaft leadout shall be furnished as specified by the company.

39. Rocker shafts shall be made from 2-inch square, cold rolled steel, with movable bearings and movable drop forged crank arms, 11¾ inches long, center to center.

Rocker shaft bearings shall be so arranged that both ends of all rocker shafts will be supported, and not more than 6 feet of rocker shaft will be unsupported.

40. Vertical wire leadout wheels shall be 10 inches in diameter.

41. All leadout appliances shall be securely fastened to leadout timbers by ¾-inch bolts.

42. The down rod shall in all cases be connected to 8¾-inch hole of lever, with jaw bent to fit either the 8¾ or 9¾-inch hole by turning the rod.

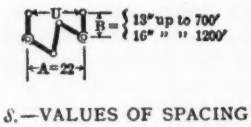
43. Shackles connected to tail levers with ⅞-inch pins shall be provided for all wire lines and sufficient movement of wire line shall be provided to successfully operate all wire-connected signals.

PIPE LINE.

48. Pipe lines shall be used for connections to switches, derails, detector bars, locks, high home signals, scotch blocks and torpedo machines.

49. One-inch soft steel or wrought-iron pipe with not less than 1¼ inches outside diameter and average not less than 1.67 pounds for each linear foot of pipe alone shall be used. The ends of the pipe shall be threaded not more than 1 inch. The pipe plugs shall be drilled for ¼-inch rivets and fastened in the pipe by ¼ by 1⅛-inch round or cone-headed rivets. Pipes shall be drilled for rivet at one end only, and be free from seams or ridges.

Sleeves for pipe couplings shall be made of wrought-iron and shall be not less than 2¼ inches in length, and full section throughout.



Values of U are based on .08 of an inch as coefficient of expansion for an increase of 10° Fahr. for each 100 ft. of line, and the nearest 1-16 inch is given.

FIG. 8.—VALUES OF SPACING "U" FOR GIVEN TEMPERATURES AND LENGTHS OF LINES TO BE COMPENSATED.

TEMP	LENGTH OF LINES COMPENSATED IN FEET											
F°	100	200	300	400	500	600	700	800	900	1000	1100	1200
110°	21¼"	21"	20¼"	20"	19¼"	19"	18¼"	18"	17¼"	17"	16¼"	16"
90°	21 1/16"	21⅛"	21"	20 1/16"	20⅛"	20"	19 1/16"	19⅛"	19"	18 1/16"	18⅛"	18¼"
70°	21 3/16"	21 1/16"	21 3/16"	21⅛"	21 3/16"	21"	20¾"	20 13/16"	20½"	20⅜"	20¼"	20¼"
50°				MEAN	TEMPER	ATURE	U=A=22"					
30°	22 5/16"	22 5/16"	22½"	22⅜"	22 13/16"	23"	23 5/16"	23 5/16"	23½"	23⅝"	23¾"	23 15/16"
10°	22 5/16"	22⅜"	23"	23 5/16"	23⅜"	23 15/16"	24¼"	24 9/16"	24⅝"	25 3/16"	25½"	25¾"
0°	22 7/16"	22 11/16"	23¼"	23⅜"	24 1/16"	24 7/16"	24 13/16"	25½"	25 11/16"	26⅛"	26½"	26 13/16
−10°	22½"	23"	23½"	24"	24½"	25"	25½"	26"	26½"	27"	27½"	28"

Since the mean temperature varies, it must be taken for the latitude where the work is done.

Plugs for pipe couplings for 1.67 pipe shall be made of wrought-iron 1 inch in diameter and 6 inches long, drilled and countersunk for 2¼-inch rivets, spaced 4 inches, center to center, and 1 inch from end. Ends of plugs shall be chamfered ⅛ inch.

50. Pipe lines shall be straight where possible, and shall be not placed less than 5 feet from gauge line, except where the line runs between tracks, or on permission being granted by the company.

Pipe lines shall be laid 2¾ inches between centers, and shall be supported on pipe carriers placed 7-feet centers on straight lines, and 6-feet centers around curve. The distance from base on which pipe carriers are supported to the center of pipe line shall be 4¼ inches.

51. Couplings in pipe lines shall be located not less than 12 inches from pipe carriers with lever on center.

53. All pipes leading across tracks shall be supported by transverse pipe carriers, fastened on top of ties.

54. Where pipe and wire lines cross tracks which are not parallel turns in pipe lines shall be made with cranks, radial arms or deflecting bars and in wire lines with chain wheels. Deflecting bars shall be arranged for pin connections.

55. Pipe connections shall be installed in accordance with temperature diagram.

PIPE CARRIERS.

67. Pipe carriers shall be made of best gray iron, constructed of individual top and bottom rollers, and with individual legs or strands coupled at the top and in contact but not connected at the bottom.

CRANKS.

72. Center pins of horizontal cranks shall be provided with top and bottom support. Cranks used for the operation of a switch and a lock for the same switch shall be mounted in separate crank stands.

JAWS.

75. Body of all jaws shall be of wrought-iron 1¼ inches in diameter and fitted with tang and thread for coupling to pipe. Tang shall be 4 inches in length and 1 inch in diameter.

76. The sides of solid jaws shall be parallel for 3 inches, and the sides of screw jaws 5 inches from center of pin holes.

77. The length of solid jaws shall be 19½ inches from center of pin hole to center of rivet hole and the length of screw jaws the same with jaw in center of thread.

78. Each screw jaw shall be provided with a jamb nut.

80. Body of screw jaws shall be of wrought-iron, 1¼ inches in diameter, with tang and thread for coupling to pipe. Tang shall be 4 inches in length and 1 inch in diameter. Special jaws made with tang ends or bodies of 1-inch and ¾-inch round may be used for immediate connections to high signals, dwarf signals, torpedoes, selectors, etc., where the resistance is less than 100 pounds.

OFFSETS.

81. Offsets in pipe lines shall be made in jaws, or in iron rod 1¼ inches in diameter. The total offsets between any two supports shall never exceed 2¾ inches. No offsets shall be made in cranks to exceed 1¼ inches.

COMPENSATORS FOR PIPE.

83. A compensator shall be provided for each pipe line over 50 feet in length and under 800 feet, with crank arms 11 by 13 inches centers. From 800 to 1,200 feet in length, crank arms shall be 11 by 16 inches centers. Pipe lines over 1,200 feet in length shall be provided with an additional compensator.

Compensators shall have one 60-degree and one 120-degree angle crank and connecting link, mounted in cast-iron base, having top of center pins supported. The distance between center of pin holes shall be 22 inches.

LOCKS.

87. Facing point locks shall be used on all switches and derails.

88. Lock castings shall be placed on outside of tracks and bolted to tie through a tieplate, ½x6 inches, placed on top of tie and securely fastened thereto.

89. Plungers shall be 1 inch in least dimension and 20 inches in length, have a stroke of 8 inches and stand not more than 1 inch clear of lock bar when switch is unlocked, and the locking ends shall be square.

90. Lock rods for facing point locks shall be run direct without side bend or goose neck from front rods into lock castings. Holes in lock bar shall have square edges and shall be not more than 1⅛ inches in least dimension.

91. All facing point switches, derails and movable point frogs on high speed routes shall be bolt locked with signals governing such route.

In all cases where switch and lock movements are used, both locks shall also be used.

92. The switch bar on all bolt locks shall have an independent connection to switch point.

93. The signal bar on bolt lock shall be made of mild steel and be a part of the line and not lugged or looped in. The switch and signal bars shall be ⅝x1¾-inch section. The notch in the signal bar shall not be more than 1½ inches in length. When two or more signal bars are used in one bolt lock, they shall be so arranged that each bar must enter its proper slot in the switch bar.

DETECTOR BARS.

98. Detector bars shall be arranged to give 50 feet continuous protection for all switches, derails and movable point frogs.

99. Detector bars shall be made of ⅜x2¼-inch steel, have square ends and bolted joints; 50-foot bars shall consist of three pieces.

100. Detector bars shall be placed on outside of rails, and move in a plane inclined toward center of track; on curves the bar shall be placed alongside of the outer rail. Top of bar shall stand ¼ inch below top of rail when lock lever is at end of stroke and shall rise not less than ¾ inch above rail.

101. Supports shall be placed 6 inches and 24 inches, respectively, from the ends, and the remaining supports not over 4 feet apart. The driving piece shall be placed midway between two supports and the driving rod shall be not less than 6 feet in length, except when rocker shafts are used. Connection from pipe line to driving piece shall be as nearly parallel with the track as possible. The crank end of driving rod shall be located not more than 8 inches from outside of rail. Where rocker shafts are used they shall be made from 2-inch square cold rolled steel, with movable bearings and crank arms interchangeable with leadout rocker shafts.

102. Where detector bar overlaps switches, special rail braces shall be provided by the company.

SWITCH AND LOCK MOVEMENTS.

108. Switch and lock movements shall be used for derails, scotch blocks and torpedo machines only, and not more than one shall be connected to a lever.

ADJUSTMENTS.

112. One turnbuckle shall be put in each pipe line between the two foundations nearest the crank at switch and lock movement and facing point lock.

Wire lines for distant signals shall be provided with two adjusting screws for each wire—one in tower and one at base of signal pole.

113. Turnbuckles shall be made of wrought-iron, with right and left hand thread, and be capable of giving an adjustment of not less than 6 inches.

114. Wire adjusting screws shall be made of wrought-iron, not less than ½ inch in diameter, with right and left hand thread, and shall be capable of giving an adjustment of not less than 12 inches.

115. Switches, derails and movable point frogs shall be provided with a special adjustment riveted to the head rod.

116. Split point derails shall open not less than 3½ inches. Lifting derails shall open not less than 5 inches.

117. Switches and movable point frogs shall open not less than 4 inches.

118. Where bolt locks are used, screw jaws or adjusting screws shall be placed in the signal line on each side of the bolt lock.

SIGNALS.

125. The height of dwarf signal poles shall be such that the lower signal arm will stand not more than 1½ feet above top of rail in normal position.

126. Semaphore arms on the same high pole shall be placed not less than 6 feet from center to center.

127. High signal arms shall be made of well-seasoned, clear white ash, or equally good material. Dwarf signal arms shall be made flexible.

128. All high arm castings shall be capable of holding three glasses 6½ inches in diameter or 8⅛ inches in diameter and ¼ inch in thickness. The back light shall be 2 inches in diameter. Dwarf signal castings shall be capable of holding two glasses 6½ inches in diameter and furnished with back glasses 2 inches in diameter when required.

129. Up and down rods for signals shall be guided every 6 feet and so connected to the arm castings that the arms will be pushed to the clear position.

130. All signals shall be provided with counterweights to assist arm to gravitate to the horizontal position.

131. On wire connected signals, the counterbalance lever shall be set parallel with the tracks.

WIRE.

140. Signal wires shall be unannealed galvanized steel No. 9 B. W. G. (.150 inch in diameter). The wires shall be cylindrical, free from scales, inequalities, flaws, splits and other defects. Each coil shall consist of one continuous wire not less than 2,500 feet in length, without joints, and shall be at least 5 feet in diameter.

WIRE CONNECTIONS.

143. Two wires shall be used for operating each wire connected signal; the normal operating wire shall have 1½ inches more stroke than the reverse operating wire.

144. Wire lines shall be carried in wire carriers on stakes placed not more than 21 feet apart and not less than 6 feet from gauge side of nearest rail, except when they can be conveniently carried on pipe line foundations, in which case 3-inch blocks shall be used to keep wire above intervening foundations.

145. Where wire lines lead around curves, the carriers shall be placed at the proper angle to prevent wire leaving groove of pulley.

146. Turns in wire lines shall be made around wheels with continuous pieces of chain made of ¼-inch iron.

WHEELS.

151. Chain wheels shall be of cast-iron 10 inches in diameter, except on dwarf signals, which may have a minimum diameter of 6 inches. Not more than three wheels are to be arranged in the same vertical line.

Diagram No. 1.

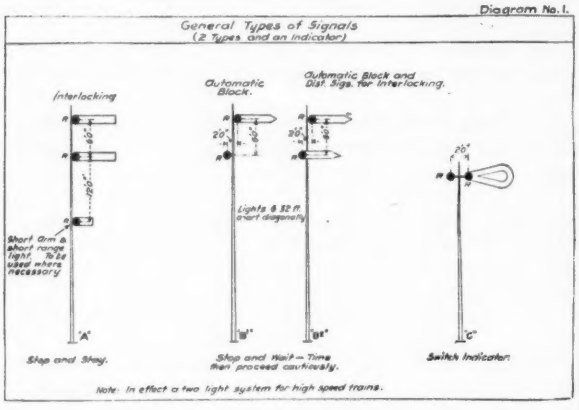

General Types of Signals
(2 Types and an Indicator)
Interlocking
Automatic Block.
Automatic Block and Dist. Sigs. for Interlocking.
Short Arm & short range light. To be used where necessary.
Lights 6 32 ft. apart diagonally
Stop and Stay.
Stop and Wait — Time then proceed cautiously.
Switch Indicator.
Note: In effect a two light system for high speed trains.

Diagram No. 2.

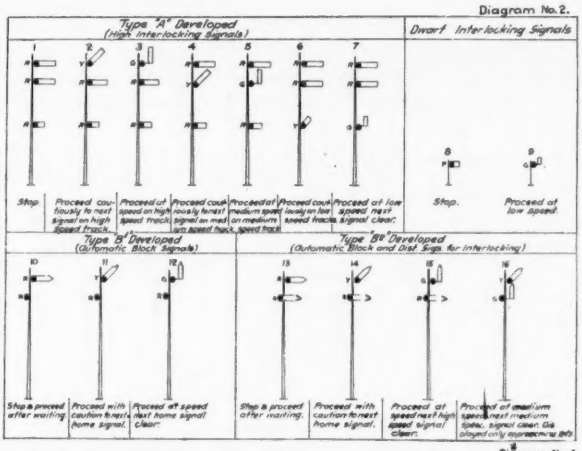


Diagram No. 3.

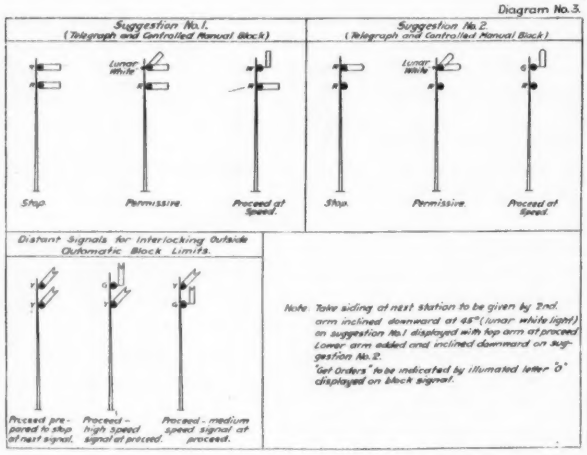
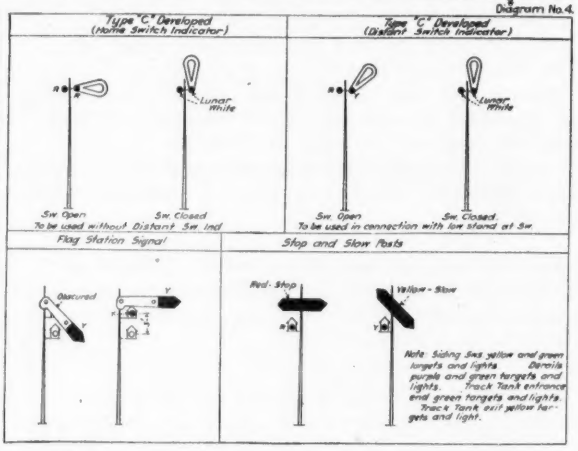

Suggestion No. 1.
(Telegraph and Controlled Manual Block)
Suggestion No. 2.
(Telegraph and Controlled Manual Block)
Lunar White
Stop.
Permissive.
Proceed at Speed.
Distant Signals for Interlocking Outside Automatic Block Limits.
Proceed prepared to stop at next signal.
Proceed - high speed signal at proceed.
Proceed - medium speed signal at proceed.
Note: Take siding at next station to be given by 2nd. arm inclined downward at 45° (lunar white light) on suggestion No. 1 displayed with top arm at proceed. Lower arm added and inclined downward on suggestion No. 2.
"Get Orders" to be indicated by illumated letter "O" displayed on block signal.

Diagram No. 4.


Type "C" Developed
(Home Switch Indicator)
Type "C" Developed
(Distant Switch Indicator)
Lunar White
Sw. Open
Sw. Closed
To be used without Distant Sw. Ind
To be used in connection with low stand at Sw.
Flag Station Signal
Stop and Slow Posts
Obscured
Red - Stop
Yellow - Slow
Note: Siding Sws. yellow and green targets and lights. Derails purple and green targets and lights. Track Tank entrance end green targets and lights. Track Tank exit yellow targets and light.

SIGNALING AND INTERLOCKING.

WIRE CARRIERS.

158. Sheaves shall be 2 inches in diameter over all.

WIRE THIMBLES.

162. Standard ¾-inch thimbles shall be used in making wire connections.

SPLIT LINKS.

165. Split links shall have ¾x1½-inch inside dimensions and be made of ⅝-inch steel. After connections are made points shall be closed.

LAMPS.

168. Lamps shall be furnished by the company.

FOUNDATIONS.

171. Pipe carrier foundations shall be concrete, 8x12x24

inches, and have top of white oak, 2½x8 inches. The top shall be fastened to the foundation by two ½x10-inch hook bolts.

172. Cranks and compensators shall be bolted to cast-iron piers set in a block of concrete not less than 2½x4x3 feet.

173. Foundations for L. J. compensators and dwarf signals shall be concrete, not less than 2½x4x3 feet.

174. The iron piers, cranks, compensators and wheels shall be arranged with slots to hold ¾-inch bolts. Plank to hold dwarf signals and deflecting bars to be fastened in a similar manner.

175. Foundations for iron bracket poles shall be of concrete, not less than 4x4x5 feet.

176. Wood top for dwarf signal and deflecting bar foundations shall be 3x12-inch white oak.

177. Foundations shall be so constructed that apparatus can be removed without disturbing foundations.

178. Wood stakes for wire lines shall be 3x4 inches x4 feet, with 7-inch point.

179. Foundations shall stand at least 10 days after concrete work is done before being connected to the apparatus.

PINS.

195. All pins shall be made of steel, accurately turned and provided with cotters.

196. Center pins for cranks, compensators and switch and lock movements shall be 1¼ inches in diameter and shall be provided with a square head or other means for conveniently turning or removing same.

197. Connecting pins for cranks, compensators, levers, selectors, signals, bolt locks, switches, etc., shall be ⅞ inch in diameter and have square heads.

BOLTS AND SCREWS.

200. All bolts shall have standard square or hexagon head and nuts.

201. All lag screws shall be standard, with square heads.

202. Two 1½-inch No. 14 drive screws shall be used to fasten each wire carrier to its foundation.

203. Six ⅜x1½-inch elevator bonds, with head 1¼ inch in diameter, shall be used to fasten each high signal arm to casting.

204. Two ¼x1-inch bolts shall be used to fasten low signal arm to casting. A single plate washer, ⅛x¾-inch, shall be used under bolt heads.

205. Plate washers shall be used under bolt heads, nuts and heads of lag screws where they would otherwise come in contact with wood.

PAINTING.

210. The machine shall be painted one priming coat and finished with two coats of black, to and including the latch shoe. The levers shall be painted three coats, as follows:

Lock levers, blue.

Distant signal levers, lawn green, or lemon-yellow.

Home signal levers, vermilion.

All other levers, black.

211. When a lever is used for more than one purpose, it shall be painted to correspond with the colors used on separate levers for same purposes.

212. The unfinished part of latch handle inside shall be painted same color as lever.

213. All painted parts of machine above floor shall have one coat of varnish.

214. The finished parts of the machine shall not be painted.

215. Signal arms shall be painted one coat of priming and two finishing coats.

216. Signal poles shall be given a priming coat of graphite paint and a finishing coat in accordance with company's standard.

217. All iron work, except detector bars, tie plates and iron foundations, shall be painted two coats of graphite paint.

218. All chain and other iron work, not machine finished, shall be dipped in oil before being shipped.

219. All boxing shall be painted two coats of metallic oxide paint.

BOXING.

225. Boxing, when it is required, shall be made of good pine lumber, surfaced on one side. Planks, 2x8 inches, shall be used for the sides and tops, and, if necessary, 1-inch rough lumber for bottom. All pipe and wire lines shall be boxed for 6 feet from rail where they cross tracks; and where highways are crossed boxing with 4-inch oak for top and sides shall be used. Where wires cross highway they must run in ½-inch galvanized pipe, provided with a stuffing box in each end, pipe to be filled with black oil.

Records, Reports and Accounts

The general purpose of the present report, in accordance with instructions from the board of direction, is to present a set of forms to be used in connection with estimating cost of work and issuing authority to proceed therewith, and

To present certain recommended standard conventional signs to be used in connection with right-of-way and topographical maps.

The committee has held six meetings during the year, and the attendance was highly satisfactory. Careful study has been given to the subjects in question, and the conclusions represent the combined judgment of the membership of the committee.

SYSTEM, AND FORMS FOR ESTIMATES AND AUTHORITY FOR WORK.

The committee presents for consideration a scheme which involves the use of three forms, as follows: Estimate (form No. 1017), Authority (forms 1018 and 1019).

GENERAL OUTLINE OF SCHEME.

There are two steps involved: First, the preparation and submitting of estimate of cost of work; second, authorizing the work to be done.

In connection with the first step, a vice-president or general manager requests the chief engineer to make a study of and submit an estimate of the cost of a proposed improvement.

The chief engineer will, after collecting the necessary data, etc., submit his estimate of cost to the vice-president or general manager on Form 1017, furnishing all the details required on said form. After due consideration, the vice-president or general manager approves of the plan and estimate and submits same to his president and board of directors. After due consideration, they approve and so inform the vice-president or general manager.

Soon after receiving this notice the vice-president or general manager will issue a Form 1018, which form will only show a brief and concise description and location of the work to be done and the lump sum amount allowed for the improvement. Also show the distribution of the expense as between construction, additions, replacements, I. & C., etc. Copies of this approved form will then be furnished by the vice-president or general manager to the chief engineer, auditor, and others interested (this depending entirely on the organization in effect on the road using the system). The auditor should furnish the number for the form.

After receiving the approved Form 1018, the chief engineer lays out his program of work, and as each piece of work in the improvement is decided upon, he will make a request (on Form 1019) on the vice-president or general manager for the necessary authority to proceed with the work and for the necessary funds.

To illustrate: We will assume that the work consists of the construction of a new branch line, involving an outlay of $1,000,000.00. The first step will be the construction of roadbed, involving grading, masonry, etc. This section of the work will be done by contract and involve an expenditure of $300,000.00. The chief engineer invites bids, and in due time bids are tabulated, and he decides to let the contract, but before actually doing so

makes a request on the vice-president or general manager for the necessary authority and funds, on form 1019. After he receives his authority from the vice-president or general manager, on form 1019, he lets the contract, and so on, as each step in the improvement is undertaken he will get the necessary authority for so doing on this form.

In cases where departments other than the chief engineer's department are interested, they will handle their requests for appropriations on the vice-president or general manager in the same manner as does the chief engineer. In case of a small job, only involving a small expenditure, where the vice-president or general manager does not deem it desirable to limit the chief engineer's authority, it would not be necessary to supplement

FRONT OF BLANK.

Form 1017 8"x13¼"

ESTIMATE No. 102

A. B. & C. R. R. Co.

P. & L. E. DIVISION

ESTIMATE based on plan No. 104 Dated Jan. 10th, 1906.

New Coal and Coke Transfer Station at McKees Rocks, Pa.

Estimate of cost of foundation, superstructure, machinery and sidings,

LOCATION McKees Rocks, North Yard - Survey Station 358+44.

FOUNDATION:			
300 cubic yards Excavation,	@ 1.00	300.00	
120 " " Concrete,	@ 10.00	1,200.00	1,500.00
SUPERSTRUCTURE:			
Contract B, building and machinery,			4,422.00
POWER:			
Wiring from Power House, - - -			1,000.00
TRACKS:			
Grading, 6000 cubic yards,	@ .25	1,500.00	
4 No. 6 80-lb. Turnouts,	@ 270.00	1,080.00	
2800 lin. ft. 80-lb. Track,	@ 1.50	4,200.00	6,780.00
9½% ENGINEERING - - - -			308.00
9½% CONTINGENCIES - - - -			990.00
GRAND TOTAL, - - - -			$15,000.00

GRAND TOTAL $15,000.00

CREDITS NONE. TOTAL CREDIT

NET $15,000.00

DISTRIBUTION OF EXPENSE.

P. & L. E.	Road or Division.	Road or Division	Road or Division.	Total
New Work (or Additions)	$15,000			15,000.00
Betterments				
Renewals or Replacements				
Individuals and Companies. (Give dates of agreements, names of parties against whom bills are to be made, amount chargeable to each, and indicate by * items in above estimate that are to be billed.)				

Correct. The above expenditure is respectfully recommended. Approved.

John Doe,

(Title) Chief Engineer. (Title) (Title)

Date Jan'y 20, '06 Date Date

FRONT M. W. FORM NO. 1017, RECORDS, REPORTS AND ACCOUNTS.

form 1018 by 1019. A notation can be placed by the vice-president or general manager on form 1018 that no forms 1019 will be required. In such cases the chief engineer can proceed with the work without any further authority.

This makes the system elastic enough to suit all conditions. In cases involving large expenditures it enables the chief executive to control the situation, and in other cases involving small expenditures he turns control over to his subordinates. He can, with this system, control the individual steps in the program of work, as well as at all times be able to tell the status of his bank account form 1018 as compared with the checks he has issued against it form 1019.

This system can also be adapted to any organization. It can be used by division engineers in the handling of their work with the engineer maintenance of way; likewise resident engineers in the handling of their work with the chief engineer.

In cases where the improvement involves the chief engineer's department, motive power department, etc., the vice-president or general manager would get estimates from the various departments interested, and in his report, say to his president or board of directors, would cover the total of his estimates, and so would his form 1018 when issued. Then he deals out the funds to the various departments interested from time to time as the occasion requires.

Form 1017, size 8"x13½", to be printed on medium bond paper (white), and will be used for submitting estimate of cost of work to the officer who issues the authority (Form 1018) for

BACK OF BLANK.

COST OF REPLACING EXISTING BUILDINGS OR OTHER STRUCTURES.

Description.		Disposition.

INSTRUCTIONS FOR USING THIS BLANK.

(1) When estimate is based upon plans, always refer to numbers and dates of plans.

(2) Observe the following rules in describing work:

(a) When additional buildings or other structures are to be built, begin your description with the word "New."

(b) When a building or other structure is to be built to replace an inferior one, or one of different kind, begin your description with the word "Replacing."

(c) In case of replacement, mention should be made of any variation from the original construction, such as:

Substituting stone for frame building.
Steel for wooden bridge, etc.

(d) When a building or other structure is reconstructed, restoring the original, use the word "Renewing."

(e) Under other conditions use a suitable word, such as:

Strengthening (Bridges).
Changing (Yard Tracks).
Altering (Buildings).
Extending or Widening (Wharves).
Improvement at (Consisting of new standard 20x40 foot frame passenger station, renewing 30x50 foot standard frame freight station, altering yard tracks, strengthening bridge $500, etc.).

(3) CREDITS. When including in the estimate material which is to be used in temporary work, allow (under head of "Credits") an amount to cover estimated value of material to be recovered.

(4) When the plan provides for replacing inferior buildings or other structures with buildings or other structures of a superior kind, always give on back of blank, in the space provided, the estimated cost of reproducing the existing buildings, or other structures, based on current market prices.

Give estimate for each building or other structure separately.

(5) On back of blank, in "Disposition" space, show disposition to be made of the abandoned buildings or other structures.

(6) DISTRIBUTION: When more than one road or division is affected, divide cost on a land ownership basis, unless otherwise instructed.

All new work can be shown as a charge to New Work or Additions.

Replacement work can be divided on the basis of charging to Replacements or Renewals the cost to reproduce the existing building or other structure, based on current market prices. The excess or difference between estimated cost and reproduction cost, should be shown under "Betterments."

Individuals and Companies. (See instructions on face of blank.)

(7) This form to be submitted in triplicate by the originating officer to the approving officer. (Estimates should be submitted as per special instructions of individual roads.) If estimate is approved, authority for performing work will be given on Form No. 1018.

(8) Number the estimates consecutively, beginning with No. 1. Revised estimates should be given a new number.

BACK M. W. FORM NO. 1017, RECORDS, REPORTS AND ACCOUNTS.

doing the work. This form, when properly filled out, should show:

(1) A reference to the plan number.

(2) A brief and concise description and location of the work covered by the estimate.

(3) Estimate of cost in detail.

(4) Credits, if any, for material to be recovered, etc., such as salvage from false-work, temporary tracks, and in case of a renewal (which renewal is occasioned on account of a fire) the amount of insurance recovered, and anything else that is a proper credit to the job.

(5) Distribution of estimated cost as between new work, betterments, renewals or replacements and I. & C.

(6) Estimate will be signed by various officers in accordance with the prevailing organization.

(7) Reproduction cost of any building or other structure which is to be replaced. This information will be required by the officer determining the distribution of the expense.

A set of instructions governing the use of the form have been provided. Special attention is called to those covering the describing of work.

Form 1018, size 8"x10½", to be printed on medium bond paper (yellow). Yellow paper is recommended so as to make this form distinctive. This form will be used by the highest executive officer to convey to those interested the fact that the work is authorized and the estimate approved. This form, when properly filled out, will show:

(1) A brief and concise description and location of the work.
(2) Estimated cost, in a lump sum, which lump sum will be the total of the estimate, or estimates, as given on form 1017.
(3) Instructions as to whether form 1019 is to be submitted or not.
(4) A reference to the number, or numbers, of estimates form 1017 which it covers, and an approved copy of the estimate form 1017 should be attached to each copy of form 1018, issued for the information of all concerned.
(5) Distribution of expense as between construction, additions, replacements, special and I. & C.

This form does not authorize expenditures of money unless it bears a notation that form 1019 will not be required. The actual expenditures of money will be authorized on form 1019, except as above noted.

Form 1019, size 8"x10½", to be printed on medium bond paper (white), and will be used by the proper officer to authorize expenditures of money for work authorized by form 1018.

This form, when properly filled out, will show.

(1) A brief and concise description and location of the work to be done.
(2) Total amount of form 1018, of which it is a part.
(3) The engineer's estimate as covered in form 1018.
(4) A detailed or lump sum amount required for the job.
(5) Distribution of the expense.
(6) Number of the form against which it applies. A designating letter in addition to the number.
(7) And any other detail required by the company or approving officer.

Forms referred to are reproduced herewith (front and back).

Form 1018
8"x10½"

A. B. & C. R. R. Co.

Pittsburg, Pa., June 2d, 19 06

Coal & Coke Transfer Station,

McKees Rocks, Pa.

Construction of Coal & Coke Transfer Station at McKees Rocks, Pa., $15,000.00

(Title of approving officer.) Richard Doe, Vice-President and General Manager.

Chief Engineer's Estimate No. 102 Dated Jan'y 20, 1906

CHARGE TO
Construction
Additions $15,000.00
Replacements or Renewals
Special
Individuals and Companies

CHARGE APPROVED:
In all Vouchers, Reports, etc. refer to
AUTHORIZATION No. 75

This authority to be supplemented by Form 1019 at the discretion of the approving officer.
The expenditures under this authority must not exceed the amount authorized. Additional authority must be obtained in case of necessity.
This authority expires at the end of the year in which issued. If work is incomplete at that time, a new authority will be issued for the following year's expenditures.

M. W. FORM NO. 1018, RECORDS, REPORTS AND ACCOUNTS.

Form 1019 A
8"x10½"

A. B. & C. R. R. Co.

Pittsburg, Pa., June 2nd, 19 06

To be expended by ENGINEERING Department, as follows:

Coal & Coke Transfer Station,

McKees Rocks, Pa.

Blanket Authority #75, dated June 2nd,

1906 - - - - - $15,000.00

Engineer's Estimate (Building and Machinery) 4,422.00

It is desired to have this work done by contract. The Link-Belt Engineering Co. agree to do the work for - - - 4,422.00

and I recommend that contract be let accordingly.

RECOMMENDED:
John Doe,
Chief Engineer.

APPROVED:
Richard Doe,
Vice-President & General Manager.

.....Estimate No..... Dated.....19....

CHARGE TO
Construction
Additions $4.422.00
Replacements or Renewals
Special
Individuals and Companies

CHARGE APPROVED:
In all Vouchers, Reports, etc., refer to
AUTHORIZATION No.....

The expenditures under this authority must not exceed the amount authorized. Additional authority must be obtained in case of necessity
This authority expires at the end of the year in which issued. If work is incomplete at that time, a new authority will be issued for the following year's expenditures.

M. W. FORM NO. 1019, RECORDS, REPORTS AND ACCOUNTS.

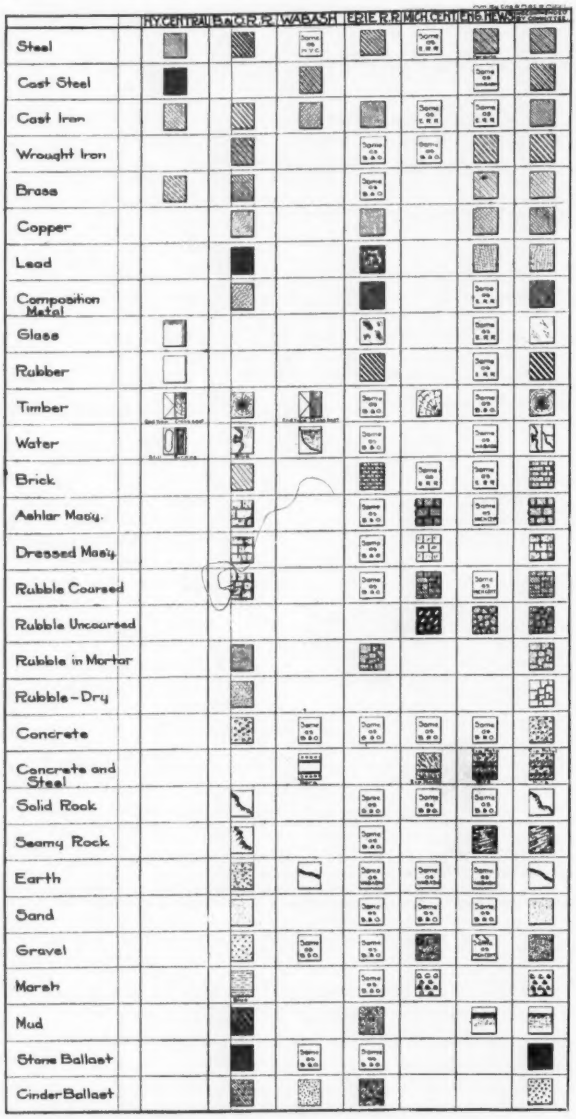
CONVENTIONAL SIGNS.

The committee has finished its study of the general subject of conventional signs to be used on right-of-way and topographical maps. The subject was under consideration last year, but it was of such general importance as to require further study. The general use of conventional signs and the great lack of uniformity in the signs used by the various railroads and technical

journals, as well as the government, prompted the board of direction to assign this subject to the committee.

The committee now presents to the association a compilation of the signs used upon a number of the railroads, as well as used by the United States Government. Many railroads informed the committee that they had no conventional signs.

In regard to signs relating particularly to signals, your committee has shown a few of the important ones required on general maps, and we endorse the signs adopted and published by the signal companies when signs other than those recommended by the committee are required. The signs herein recommended for signal work are those shown herewith. (Reference is here made to that general list of conventional signs agreed upon by

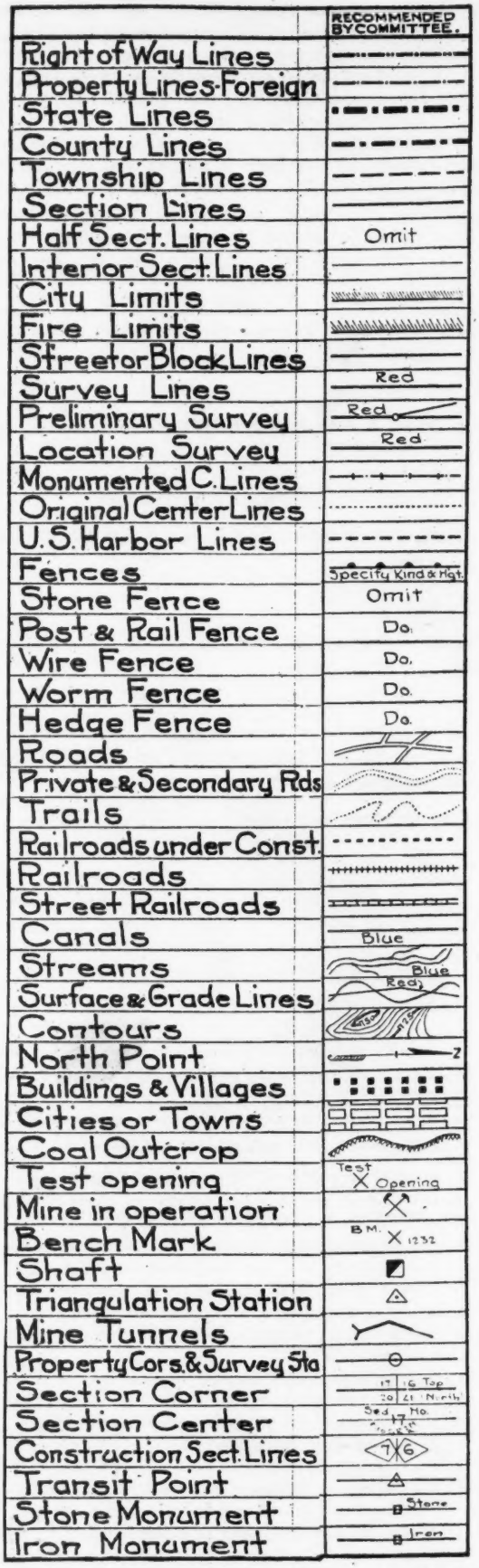


CONVENTIONAL SIGNS. M. W. FORM NO. 1021, RECORDS REPORTS AND ACCOUNTS.

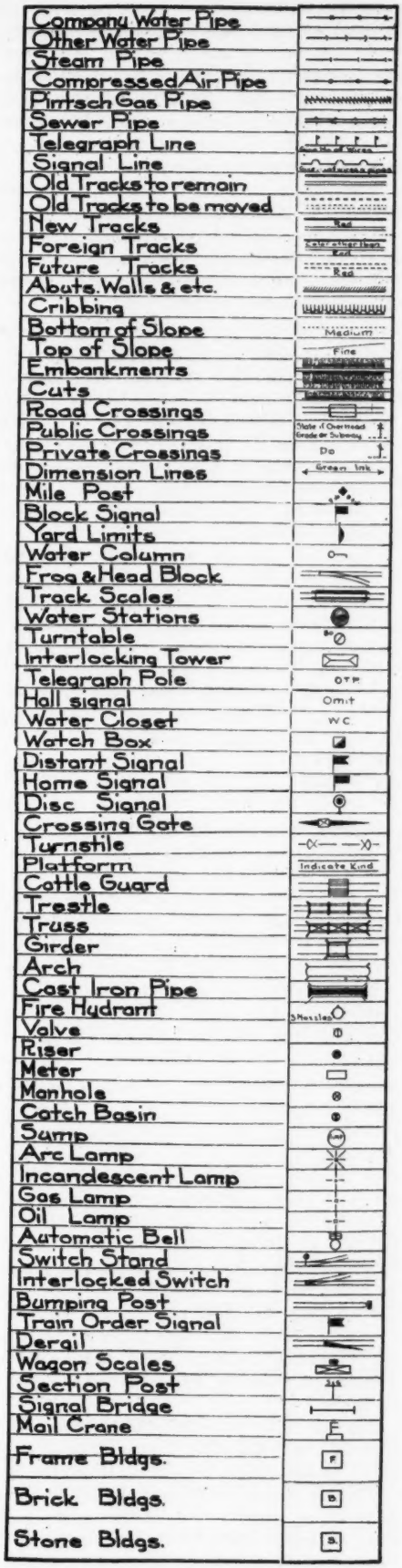
the various signal experts of this country, under the direction of the leading signal companies of America. These are in pamphlet form and may be obtained, without charge, from the signal companies.)

For convenience the various conventional signs recommended by the committee are divided into three groups, and for convenience these forms have been numbered M. W. 1020, M. W. 1021 and M. W. 1022.

The conventional signs recommended by the committee are illustrated herewith.



CONVENTIONAL SIGNS, M. W. FORM NO. 1020, RECORDS, REPORTS AND ACCOUNTS.



CONVENTIONAL SIGNS, M. W. FORM NO. 1022, RECORDS, REPORTS AND ACCOUNTS.

REVISION OF THE MANUAL.

The committee has carefully studied the contents of the "Manual of Recommended Practice," especially that portion which relates to "Records, Reports and Accounts." We believe that the contents of the "Manual" is the result of careful and exhaustive study and that, until such time as the practice recommended in the "Manual" has been thoroughly tried under general conditions prevailing in the railroad business, no change in the "Manual" is desirable.

CONCLUSIONS.

(a) Construction, addition or betterment work should be authorized in accordance with a reasonable and simple system, involving the preparation of estimates of cost and the formal authorization of the expense by executive officers, and it is recommended that forms M. W. 1017, M. W. 1018 and M. W. 1019 be adopted as representing good practice.

(b) Standard conventional signs for use on right-of-way, topographical and other maps are desirable in railroad work, and the approved conventional signs illustrated on forms M. W. 1020, M. W. 1021 and M. W. 1022 are recommended for adoption as good practice.

(c) It is recommended that the board of direction send a letter of inquiry to the managements of the different important railways of America, requesting information showing what portions of the "Manual of Recommended Practice" have been adopted as standard in the conduct of work on their roads and inviting criticism of the practice therein recommended.

(d) We recommend that form M. W. 1013, on page 75 of bulletin No. 79, September, 1906, be eliminated from the "Manual of Recommended Practice," because forms M. W. 1018 and M. W. 1019 are now substituted.

(e) We recommend that form M. W. 1014, on page 76 of bulletin No. 79, September, 1906, be referred back to the committee for further consideration, discussion and study, and that the committee be instructed to submit a final report in regard to "Individual Ledger Accounts" in its 1908 report.

Economics of Railway Locations

The committee on "Economics of Railway Location" was formed for the consideration of all questions connected with railway location, grades, lines and improvements of grades and lines affecting the economic operation with relation to traffic, tonnage ratings, speed, density of traffic and financial considerations, with the special aim in view of establishing uniform methods and unit values for investigating and analyzing the relative changes and costs of comparative routes or proposed grade reductions and line corrections.

The first report of progress submitted herewith is indicative of the vast field embraced by the scope of work relegated to its consideration, rather than as conclusive of any one of the several details set forth in the instructions to the committee.

It will be realized that much of the matter proposed to be investigated depends largely upon the relationship of the financial question and the economics of trade, to the purely engineering features, and that the true economics of the latter depend in a considerable degree upon the results arrived at by experiment.

The conditions under which experiments have hitherto been made, as well as those at present governing actual practice on the existing lines, are so varied, that, without further investigation, your committee is, as yet, unable to formulate or definitely recommend any set rules or empirical formulas that will accurately cover any of the sub-features embraced in this province of its work.

Generally, and with special reference to the work of this committee, it may be said without question that, viewed from a modern standpoint, much of the railway construction in the early days of the development of the North American continent was of an inferior character. Great distances had to be traversed, the population of the country was sparse and scattered, and the

gradients and curvature were, therefore, too frequently determined by the amount of money to be expended per mile of road, rather than by a consideration of the probabilities for future traffic and the economic value of grade and alinement features.

Commercial progress of the country, however, followed the introduction of the railway, and the financial problem of how to make a dollar earn most, began to receive greater consideration.

For a number of years past, the larger railway organizations have been spending large sums of money in improving the properties under their charge; but while there has already been an immense outlay in this respect, it may be said confidently that betterments in the future, both in new locations and in revision work, will be on a much greater scale than those of either the past or present.

The general situation necessitating such changes may be said to be the outcome of circumstances. It is due in a great measure to a realization of the saving in operating expenses resulting from such betterments, to the increasing demand for cheaper rates and better service, the competition of railways with one another, and, more especially, to the construction of new lines designed on better economic principles.

In the effort to reduce train mileage, locomotives and rolling stock generally have been greatly increased in size, weight and capacity; and the effect of such changes has been: Bridge structures of increased strength, heavier rails, securer joints, more and better ballast, wider roadbed, and, consequently, an improved railway.

Besides changes of this nature, however, it soon became recognized that many improvements might be made in the distance, gradients and alinement of the earlier construction which would effect a reduction in train mileage, independent of the class of rolling stock used. The province of this committee is, therefore, to investigate certain economic principles, in order that, eventually, helpful suggestions may be made to railway engineers and railway managers engaged in the construction of new lines, as well as of grade and alinement revisions.

It is usually comparatively easy to estimate the cost of a projected railway or an improvement to an existing one. The actual cost, however, of operating such a line, or the value of the saving in operating expenses which is rendered possible by any proposed physical change in the road or in the method of operating its trains, due to a modification of alinement, distance, or gradients, is more uncertain.

Before the proper location or re-location of a railway can be decided intelligently, it is necessary that the factors governing its earning power be properly understood, and the relation between the purely engineering and the financial features thoroughly grasped. Railways are built as commercial undertakings for profit, and a railway that can furnish the most economical transportation, time as well as money being considered, will finally show the best net earnings.

The three principal factors which affect profits, viz.,—gross earnings, operating expenses and fixed charges, are, in a great measure, dependent upon the location of the road with regard to the sources of traffic. With a gross amount of traffic and proper location and construction, the greater the first expenditure (with its consequent improved road) the less will be the operating expenses, but the greater the fixed charges. Increasing one decreases the other. With a given volume of traffic, the economic location is the one in which the sum of fixed charges and operating expenses is the least; and a more economical location is obtained when interest and renewal charges on additional expenditure for construction are saved in decreased operating expenses or when increased operating expenses are saved in reduced interest and renewal charges on cost of construction. The most economical location is secured when every gain possible has been effected, both by decreased cost in the one case and decreased operating expenses in the other. In grade reduction, it is the saving in number of trains, even if each train costs somewhat more.

The effect of differences in location on such factors must be understood before a proper and economic location can be determined. If it can be computed that by certain physical alterations in alinement or gradients, or by any change in the method of operating trains, the expense of each train over a proposed line or the number of trains to handle a given traffic can be reduced, then the only problem remaining is the financial study of the relative values of the proposed expenditure and the expected annual saving. A general and purely academic discussion of some features of this question may profitably precede the future consideration of details.

It is often stated that any really meritorious proposition can command the requisite capital, provided that it is properly exploited. Although there is considerable truth in this statement, it is also true that there is a wide difference in the amount of effort necessary to raise money, depending on the status of the corporation making the effort. It is perhaps unfortunate that the financial standing of many railroad corporations is so unlimited, that many changes, which probably could not be justified by any rational method of computation, are recklessly made after slight consideration. There may be little or no reduction in operating expenses and certainly not enough to justify the capital expenditure, but the financial strength of the company is so great that there is no reduction in dividends. There may be an actual increase in dividends, which only means that the financial strength of the road is so great, and is growing so rapidly, that the comparatively insignificant loss, due to fixed charges on an unjustifiable expenditure, is utterly swallowed up. On the other hand, the road which is financially weak must show unquestionable justification for any proposed improvement, and even then the financial reputation may be so limited that a really meritorious project may fail for lack of funds.

There can be no question regarding the justification of providing for traffic that may reasonably be expected for a considerable period after the plans are made.

A railway is not built for a day's work. There will be an interval of a year or more after the plans are made before the road is built. Several years more may elapse before the normal traffic is obtained. If the increased traffic cannot be economically handled with the facilities provided, then the railway is confronted with the choice between an uneconomical handling of traffic or an immediate additional expenditure with its accompanying loss and waste of work already done.

Of course, much depends upon the character of the change and the amount of the waste. In territory where the topographical features are extreme and the financial aspect a governing element, cases may arise in new construction in which it is necessary to temporize with the profile in regard to limiting grade; that is, to construct a temporary line with grade steeper than the limiting one, a line which will be used until future traffic conditions warrant the construction on the alinement as projected. In such cases, in the consideration of the economic value of reducing the grade, it must be taken into account that the cost of any temporary work thrown away must eventually be borne by the permanent line. This fact should emphasize the desirability of avoiding temporary work whenever the finances of the company warrant the immediate construction of the permanent line.

It is conceivable that a considerable improvement may be made by merely heightening a fill in a sag without altering the horizontal alinement. The additional work in this case will cost but little more than it would have cost originally, with the advantage of saving several years' interest on the added cost. In the other extreme it might be necessary to utterly abandon

a considerable section of the line, and in such case the road would become perpetually burdened with an interest charge on both lines. The very patent fact that improvements, especially when not planned during the original construction of the road, so frequently require the abandonment of considerable old work the cost of which will be perpetually represented in the fixed charges, causes a delay in the reconstruction for a number of years until the disadvantages of uneconomical operation become so great as to be intolerable.

The possibility of permanently utilizing the temporary line as a branch line, or even as a mere freight track by which to reach factories and other industries, may exclude all permanent loss from the question. It may happen that the line can be used to handle the local traffic, and one more direct for through business built later; the temporary line could then be used as a second track if the gradients are favorable in one direction. In this case one would be enabled to "eat his cake and keep it, too." The cheap temporary line serves its original purpose and saves the immediate construction of the expensive permanent line, and yet both the preliminary and the later expenditure are fully justified by their utilization.

As a practical result, it may be taken for granted that a much heavier traffic is needed to justify the abandonment of a temporary line than would justify the construction of a permanent line designed for heavy traffic.

A very interesting collection of figures has recently been brought to the notice of the committee. The name of the road and the exact location of the improvement need not be stated, but the essential facts and figures are given. A section of the road over 83 miles long was built originally with very sharp curvature and heavy grades in order to reach certain coal fields.

It was considered imperative to reach the coal fields at once, and therefore the construction of an alternative shorter low-grade line was deferred. About two years ago, the low-grade line was completed, at a cost of nearly five million dollars for 59 miles of road. Over 24 miles of distance is saved by the new line. The limiting grade against east-bound traffic has been reduced from 0.91 per cent. to 0.05 per cent. The limiting westbound grade on the old line is 1.15 per cent. On the new line, with the exception of a 0.24 per cent. grade on the approach to a bridge, there is no grade against westbound traffic. The total rise against eastbound traffic was reduced from 687 ft. to 69 ft., and against westbound traffic from 438 ft. to 17 ft. The maximum rate of curvature was reduced from 12 degrees to 6 degrees and the total curvature from 19,783 degrees to 5,075 degrees. The average degree of the curve was reduced from 7 degrees 50 minutes to 3 degrees 19 minutes. This required 10,222 ft. of tunnels as against 4,096 ft. on the old line. In this case, however, the old line was not abandoned. It is still used for trains of eastbound empty coal and coke cars. But all the westbound business and also the eastbound time freight passes over the new line. The two lines may virtually be considered as a double-track line.

The results of this improvement are given by a comparison of the business of the year 1904, handled entirely on the old line, and that of 1905, handled on both sides as described above. Notwithstanding an actual growth in business of 22 per cent., the work was done with an economy of 2 per cent. in freight engine mileage, besides the disuse of three pusher engines, with a mileage of 138,816 miles in 1904. Again, in spite of 22 per cent. increase of business, the freight train wages were actually 19 per cent less than in 1904. On account of the relief of the congestion of the old line, the overtime of the freight trains was reduced from $80,000 to less than $43,000, a saving of 46 per cent. The average time of freight train runs was reduced from 18 hours 28 minutes to 12 hours 35 minutes, a saving of 32 per cent.

After allowing for the increase of 22 per cent. in traffic over the figures for 1904 and comparing these figures with the actual figures for 1905, it was estimated that the saving in operating expenses resulting from the construction and operation of the new line amounted to nearly $238,000, which is nearly 5 per cent. of the total cost of the new line. It is also claimed that the $238,000 does not fully measure the true saving owing to the fact that the old line was already being worked to nearly the limit of its capacity. But even accepting that figure as correct, a saving of 5 per cent during the first year after construction may be considered a remarkable justification of the construction of the new line.

While the committee realizes that all the facts bearing upon this comparison are not stated, and are not available at this time, nevertheless it considers that what is given may be of considerable interest and value to the members.

In regard to the period for which future traffic should be discounted, by the very nature of the case it varies with the character of the temporary line, the capital which will be wasted in abandoning the temporary line and the probable rapidity of growth of the traffic. It also depends upon the very variable and almost indeterminate annual loss due to uneconomical handling of traffic. Even the temporary line is supposed to be so designed that the existing meager traffic is handled as economically as is justified by such traffic. The growth in traffic is literally a growth, and does not increase by leaps and bounds. The justification of the larger expenditure changes from zero at the beginning of the period to some larger amount at which a change is imperatively demanded. Even the change, although gradual, is not necessarily at a uniform rate. There can be no empirical rule for determining the number of years in advance that it is desirable to provide for, but if the actual tonnage for a considerable period of years is plotted to form a curve, the extension of the curve will give probably the best obtainable prophecy of future traffic. Where changes can be cheaply made afterwards a small number of years seems proper, but where alterations suitable for increased traffic would mean the entire disuse of much expensive work, a much longer period in advance is advisable.

A consideration of the foregoing uncertainties will show that a definite mathematical solution is seldom possible. It would appear as if the question must be finally determined by judgment, although the judgment should be guided by a careful consideration of all the modifying elements, and each change should be considered by itself even on the same road.

Your committee finds that at almost every step in the study of the "Economics of Railway Location," whether it be in connection with rise and fall, distance, curvature, or the adjustment of grades in any of its phases, the element of train resistance is very near the basis from which the investigation must be pursued. It has, therefore, seemed to the committee that this report should with propriety deal with this very important subject, and take up with some thoroughness the consideration and comparison of the various formulas for train resistance. In connection with these formulas, of necessity much attention must be given to a consideration of the elements of factors or influences which affect this resistance, and of the views about it which have been entertained by those who have given special attention to this subject.

It is hoped that this report will call attention to the many features of train resistance, and to the difficulties in arriving at proper results, so that the outcome may be many new experiments made under favorable auspices upon track substantially standard, in such a way that results found even in different places may justify comparison.

Your committee, however, feels that conditions in different parts of the country are still sufficiently unlike so that it is desirable that each company should do some work upon such matters, under the local conditions that there prevail.

The balance of the report covers 92 pages, devoted largely to developing recorded experiments on train resistance. Some sixty different formulas are referred to as well as various curve included in the report. It is published in Bulletin No. 84 and will be found very valuable for reference.

In conclusion your committee is desirous of making the following recommendations:

(1) That each company conduct its own experiments for train resistance.

(2) For the present for such experiments the dynamometer method shall be used, and the resistance of train alone determined.

(3) That the determination of the amount of pull available at the drawbar at various speeds for locomotives of the different classes, be left to the proper motive power officials.

(4) That speeds be determined as closely as one-tenth mile per hour.

(5) That for experiments on heavy freight trains at low speeds, the formula should have the shape $r=a+bV$.

(6) That an additional term be added to show the effect of loading.

(7) That all tests for train resistance should be made on tangents.

(8) That for determining the sum allowable to save curvature, or to save rise and fall, the average line for train resistance should be used.

(9) That for grade revision, for questions of momentum grade, a maximum line above the average train resistance should be used, a line somewhat near the outer edge of the experiments plotted in a diagram.

Buildings.

The report on "Buildings" commences by giving a summary of former reports and in making some explanations about their conclusions the committee reports as follows:

In Vol. 7, page 626 (Railway Engineering and Maintenance of Way, April, 1906, page 112), is a statement of the advantages in favor of a circular roundhouse. The committee in stating, under item "K," that "at the expense of roofing over the turntable, the loss of heat by open doors may be reduced to a minimum," does not wish to be understood as recommending the construction of this roof, as it is convinced that the saving in heat will not justify the expense of the roof. In the same report (Vol. 7, page 631) the conclusion on roundhouse doors, description of the various designs and recommended practice, is "roundhouse doors should be made of non-corrosive material; they should be easily operated, fit snugly, be easily repaired and maintained, and should admit of the use of small doors."

This is still thought to be the description of a perfect door, but as it apparently excludes some of the best designs of doors now in use, your committee, after additional experience and further investigation, wishes to recommend the use of rolling slat doors in roundhouses where steam and smoke are not allowed to escape into the house. (In the opinion of your committee, proper roundhouse practice requires adequate provision to prevent the escape of steam and smoke into the roundhouse.)

Referring to the discussion on page 639, Vol. 7, on gradient of tracks leading from roundhouse stalls to the turntable, your committee has obtained the result of the best experience on several of the largest systems in this country, and has found no good reason for changing from the established practice of making these tracks level.

In reporting on the current practice and designs for locomotive coaling stations showing typical plans, with discussion of the salient features of each, reference is made to Vol. 3, pp. 149-163.

A locomotive coaling plant should minimize:

Delays to engines while coaling.

Delays to coal cars.

The cost of handling coal.

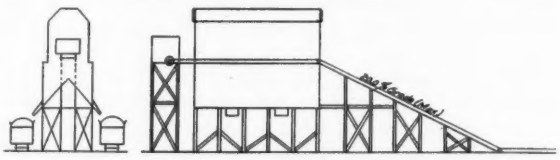
Sometimes it is also desired to accurately measure the coal as delivered to locomotives.

An ample storage capacity insures against delays, due to interruption of coal supply, to bunching of engines and to breakdowns, derailments and necessary repairs. At important points, it is sometimes desirable to provide duplicate machinery.

The roundhouse track arrangement should be as compact as possible and at the same time allow the necessary free movement. The question of the proper location of the coaling plant with reference to the cinder pit depends upon the type of plant adopted. In cold weather, delay to the engine after the fire is cleaned is liable to cause leaking, though some of the trouble attributed to this cause is probably due to an unwise use of the injector. Some handle cinders with the machinery for handling coal. This practice is, however, not recommended.

The importance of providing storage room so as to cut down the delay of cars as much as possible is ordinarily underestimated. One day's storage in cars of locomotive coal for the Pennsylvania system costs more than $300,000.00 a year, figuring

Long Approach Trestle.



Power Hoist Trestle.

that the cars are worth only one dollar a day each. An expenditure of $4,000,000.00 would be justified to avoid holding two days' supply of coal in cars, considering that the structure costs 15 per cent. of the original cost for interest, depreciation and maintenance.

Figuring 40 tons to the car, storage in cars costs 2½ cents per ton per day, and an expense of $61.00 a ton is justifiable to avoid it. Ordinarily, storage in the bin is much cheaper than in cars, yet the usual practice is to keep from one to five days' supply stored in cars at the different plants.

Theoretically, a coaling plant should be designed to take care of all the coal to be held for emergencies, so that cars can be released promptly upon arrival. This is, of course, not always feasible.

All plants for self-clearing cars should have the hoppers wide enough so that the coal can be shoveled from flat bottom cars by hand, if desired, and so that side dump cars can be used.

Self-clearing cars can be unloaded into a hopper for at least six cents a ton less than the cost of unloading flat bottom cars by hand. Using fifteen per cent. per annum of the original cost as the cost of the plant, an expense of $146.00 is justified to save handling one ton a day by hand.

In the following statements, the figures which are not available have been estimated. In order to make a fair comparison, we have assumed that it is desirable to hold at the plant, either in cars or in the bin, a total of three days' supply.

The figures presented are of value in a general way only. We have used ten per cent. of the original cost for interest and depreciation for all plants, independent of the character of construction. Considering the present rate of development, the necessary changes in terminals, etc., this is believed to be none too high. A good many of the plants reported have not been in operation long enough and the length of time over which the costs extend is too short, in most cases, to make the maintenance figures reliable. The lack of uniformity in the collection of the

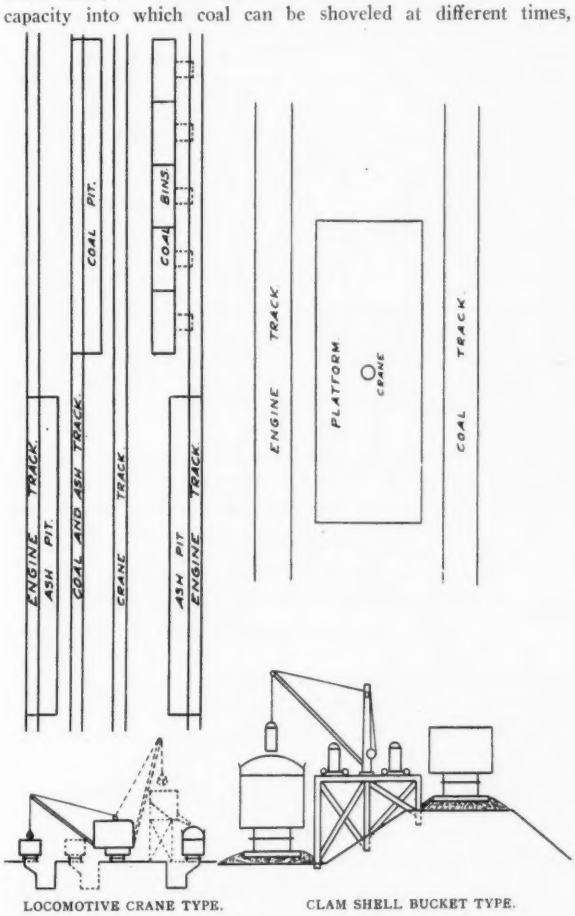
statistics and the varying conditions under which they were prepared, make any close comparisons of little value. They indicate how much a slight variation in the conditions not generally considered can affect the cost. In considering this question, it should be remembered that a saving of dollars per year for the railroad and not cents per ton for the individual plant is the result to be aimed at.

Where the quantity of coal handled is small and especially at terminal points where the engines lie over night and the coaling can be done by the hostler or watchman, coaling direct from the cars is the cheapest. This work can be helped by elevating the track, on which the coal cars stand, from two to four feet above the locomotive track.

Shoveling from the coal car direct into the locomotive has the advantage that it delivers the coal in the best possible condition. Crushing, due to handling, is kept at a minimum and large lumps can be broken up ready for the fire by the shoveler. The tendency of large bins to separate the slack from the lumps is avoided.

COALING FROM CARS AND JIB CRANE TYPE.

Where the engines are needed as soon as they can be cared for, where they come bunched or where the holsters cannot do all the coaling in connection with their other work at the time desired, it is recommended that there be, in addition to the elevated track, an elevated platform with buckets of about one ton capacity into which coal can be shoveled at different times,



LOCOMOTIVE CRANE TYPE. CLAM SHELL BUCKET TYPE.

these buckets to be raised by a jib crane which can be operated by hand or by air from the engine, and to be emptied when the engines come too fast for the men to take care of them. By this method the cost can be kept down to almost that of coaling direct from the cars into the engines. These buckets can be used for emergency coaling stations en route where coal is only occasionally required. By having, instead of buckets, small dump cars on an elevated platform and the coal car track elevated considerably above the track on which the locomotive stands, more engines can be coaled quickly.

THE WILLIAMS-WHITE TYPE.

By still further increasing the elevation, the shoveling can be done directly into bins, by which the amount stored can be increased and a larger number of engines accommodated promptly. These bins can be filled with different amounts of coal, so that, by selecting the bin, the amount needed can be obtained.

With all of these designs, flat-bottom cars are practically necessary.

The cost per ton of handling coal at four plants on one division where the coal is shoveled from the cars into locomotives at three points and into small dump cars at a fourth, gives the following averages:

Tons handled per day	157
Interest and depreciation	0.2 cent
Operation	10.4 cents
Maintenance	0.1 cent
Car storage	6.6 cents
Total cost per ton	17.3 cents

One plant handling twelve tons per day with a jib crane costs as follows:

Interest and depreciation	1.4 cents
Operation	12.3 cents
Maintenance (Est.)	2.0 cents
Car storage	7.5 cents
Total cost per ton	23.2 cents

Another plant handling 13 tons a day with buckets and a jib crane had charges as follows:

Interest and depreciation	1.7 cents
Operation	20.6 cents
Maintenance	2.2 cents
Car storage	7.5 cents
Total cost per ton	32.0 cents

Four plants on another railroad handling coal shoveled into small dump cars show an average cost of nine months as follows:

Tons handled per day	235
Interest and depreciation	0.8 cent
Operation	10.3 cents
Maintenance	0.5 cent
Car storage	6.2 cents
Total cost per ton	17.8 cents

Another railroad having five trestle plants at which the coal had to be shoveled, shows the average cost as follows:

Tons handled per day	133
Interest and depreciation (Est.)	1.0 cent
Cost of operation	11.3 cents
Maintenance (Est.)	0.5 cent
Car storage	4.7 cents
Total cost per ton	17.5 cents

THE TRESTLE TYPE.

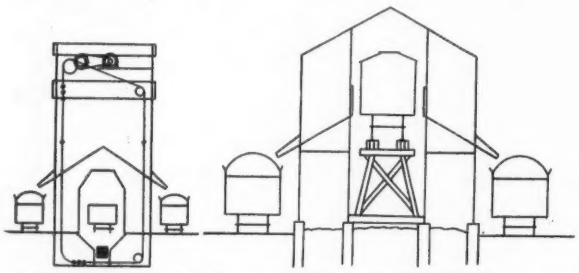
The next step is the construction of the high trestle with the coal car track on top of the storage bins, thirty or forty feet above the engine track. The cost of switching is increased, but by the use of self-clearing cars the cost of delivering coal from the cars to the bin can be almost entirely eliminated. The maximum grade of the approach desirable is usually considered as five per cent. Where the coal is not shoveled, this type of plant keeps the breakage of the coal at a minimum of all plants where the coal is not shoveled by hand.

In considering the expense of operating these plants, the cost of placing the cars on the trestle by a locomotive, an expensive and dangerous operation, is not ordinarily included.

Six trestles on one railroad for ten months give the following figures:

Tons handled per day	305
Interest and depreciation	0.5 cent
Operation	3.1 cents
Maintenance	0.5 cent
Car storage (Est.)	5.0 cents
Total cost per ton	9.1 cents

About ninety per cent. of the cars handled at these plants were self-clearing.



LINK BELT CONVEYOR TYPE. WILLIAMS WHITE TYPE.

Two plants operating for one month on another road give the following information:

Tons handled per day	370
Interest and depreciation (Est.)	1.2 cents
Operation	6.1 cents
Maintenance (Est.)	0.6 cent
Car storage	4.3 cents
Total cost per ton	12.2 cents

Seventeen plants on another road operated with all self-clearing cars for one month show as follows:

Tons handled per day	444
Interest and depreciation (Est.)	0.8 cent
Operation	3.6 cents
Maintenance (Est.)	0.4 cent
Car storage (Est.)	5.0 cents
Total cost per ton	9.8 cents

One plant of this type for nine months shows a cost as follows:

Tons handled per day	67
Interest and depreciation	2.3 cents
Operation	2.8 cents
Maintenance	0.1 cents
Car storage (Est.)	5.0 cents
Total cost per ton	10.2 cents

Seventy-five per cent. of the cars used were self-clearing.

POWER-OPERATED TRESTLE TYPE.

Instead of using a locomotive to place the cars, these plants can be equipped with a hoisting engine, allowing the use of a twenty per cent. grade. The machinery costs less than the trestle approach, much ground space can be saved, and the operation is cheaper and safer when the cost of switching is considered. This type ordinarily increases the possibilities of providing storage room and does away with a considerable liability to accident.

One plant of this type in operation for three months costs as follows:

Tons handled per day	264
Interest and depreciation	1.7 cents
Operation	3.5 cents
Maintenance (Est.)	0.8 cent
Car storage (Est.)	5.6 cents
Total cost per ton	11.6 cents

Five of these plants, handling 166 tons per day, show costs as follows:

Interest and depreciation	2.7 cents
Operation	5.1 cents
Maintenance (Est.)	1.3 cents
Car storage	0.0 cent
Total cost per ton	9.1 cents

These plants had a large proportion of self-clearing cars.

Fifty-five of these plants on one system average as follows:

Tons handled per day	82
Interest and depreciation	2.7 cents
Cost of operation	7.0 cents
Maintenance	0.9 cent
Car storage	3.7 cents
Total cost per ton	14.3 cents

These figures are for one month, in which from sixty to seventy per cent. of the cars were self-clearing.

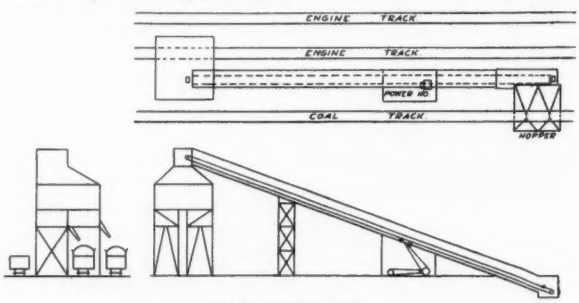
Where more than two tracks are to be served, and the necessary room is available, the coal car track can be put at right angles to the locomotive tracks. In some cases, where it is desired to coal on four tracks or on two main tracks, duplicate plants are constructed.

The trestle types are handicapped by the fact that the structure must sustain heavily loaded cars and engines or have power available to raise the cars. The costs per ton of maintenance are higher than is generally assumed, and if a fireproof structure is built, it would be expensive. They ordinarily cannot be placed in the most desirable location, and are not available in many cases where the room is cramped.

LOCOMOTIVE CRANE TYPE.

At terminals, where the demands are not so great, coaling can be done by means of a locomotive crane handling the coal direct from flat bottom cars to a locomotive. This crane can also help switch coal cars, if necessary, and can handle cinders and sand. To allow the use of drop bottom cars, a pit can be constructed from which the crane can handle the coal. To avoid delay to locomotives, a trestle can be constructed on which the crane can work, so that it can load direct into bins, in which a fair amount of storage room can be provided. The bins are not protected from the weather, and the coal and the gates are liable to be frozen up.

With the necessary tracks, the pit and the hoppers, it will be found that this sort of a plant has a considerable first cost. Its cost of operation depends upon the work which can be provided



ROBBINS BELT TYPE.

for the crane at spare times.

Its value is great in emergency situations and at points where, because of impending changes, the construction of a permanent plant is unwise.

With a large terminal, where a conveyor plant is used, a locomotive crane would be very valuable to handle cinders and sand and also coal during a possible breakdown of the conveyor.

The practical limit of a locomotive crane is said to be about 70 engines a day.

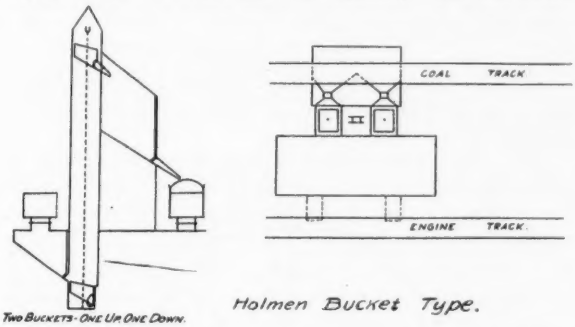
The fact that it can unload direct from flat-bottom cars is much in its favor.

Three of these cranes, besides handling cinders, show the following costs for two years' operation, coaling direct from cars:

Average tons handled per day	195
Interest and depreciation	1.5 cents
Operation	3.9 cents
Maintenance	0.5 cent
Storage	7.5 cents
Total cost per ton	13.4 cents

CLAM-SHELL BUCKET AND TROLLEY TYPE.

A type of plant using a special bucket of the clam-shell type operated on a trolley has been suggested. This can handle



Holmen Bucket Type.

coal direct from a pit or from flat-bottom cars into bins over the tracks, and can also handle cinders. While this device has not yet been tried for coaling locomotives, it is receiving more or less attention and will undoubtedly be tested soon. The number of tracks it can serve is unlimited, and the mechanism is simple. The horse-power required is small and the first cost is not excessive. This type would be especially valuable where self-clearing cars cannot be regularly obtained and where large storage is desired.

It is believed that with a plant of this type, coal can be handled at a reasonable cost from flat-bottomed cars. There should be no difficulty in getting an actual working capacity of seventy-five tons an hour, which is ordinarily ample.

THE HOLMEN TYPE.

When the space is more or less limited and the amount of coal to be handled and stored is not too great and deep, foundations can be constructed, the coal can be lifted into bins by means of two large buckets, operating opposite each other, so that when one is lowered, the other is raised. The coal is delivered into the buckets by gravity from the bottom of a pit under the coal car track through a gate worked by the operator of the bucket. The bucket is automatically dumped into the bins at the top. It requires the continuous attention of a man operating it, but is an efficient machine where the requirements are not too great. The storage room in the bins is limited by the fact that this plant has practically but one point of delivery into the bins.

Six plants of this type on one road have been operated for ten months, with sixty-three per cent. of self-clearing cars, as follows:

Average amount used per day	247
Interest and depreciation	1.9 cents
Operation	4.5 cents
Maintenance	0.5 cent
Storage in cars (Est.)	4.3 cents
Total cost per ton	11.2 cents

Another road's average for one plant for three months is as follows:

Tons handled per day	113
Interest and depreciation	2.2 cents
Operation	3.5 cents
Maintenance (Est.)	0.5 cent
Storage	2.0 cents
Total cost per ton	8.2 cents

Figures from a third road for one plant for one month, using about two-thirds self-clearing cars, are as follows:

Tons handled per day	50
Interest and depreciation	3.8 cents
Operation	8.7 cents
Maintenance (Est.)	0.5 cent
Storage	2.5 cents
Total cost per ton	15.5 cents

THE LINK-BELT TYPE.

The bucket conveyor or link-belt type requires a small ground space, has great flexibility of adjustment to suit different conditions, and can be used for almost any situation desired.

With the softer grades of bituminous coal, such as that from the Indiana field, these plants tend to break up the coal.

Many of these plants are in operation, and, where well cared for, they are giving excellent service.

The expense of power and repairs are not great, and, where the conditions are such as to recommend their construction, they give good service at a reasonable cost.

The average from one plant for six months is as follows:

Tons handled per day	165
Interest and depreciation (Est.)	3.7 cents
Cost of operation	2.7 cents
Maintenance (Est.)	1.0 cent
Car storage	4.4 cents
Total cost per ton	11.8 cents

One plant having five years' operation shows results as follows:

Interest and depreciation	2.0 cents
Operation	4.9 cents
Maintenance	1.6 cents
Storage	5.8 cents
Total cost per ton	14.3 cents

Three plants on another road, for one month, which handled 147 tons each day, show as follows:

Interest and depreciation	2.5 cents
Operation	3.7 cents
Maintenance (Est.)	1.0 cent
Car storage	4.1 cents
Total cost per ton	11.3 cents

Four plants on another railroad handling an average of 345 tons per day, with about eighty per cent of self-clearing cars, show the following:

Interest and depreciation	1.8 cents
Operation	2.4 cents
Maintenance	0.5 cent
Car storage	4.7 cent
Total cost per ton	9.4 cents

One plant, built under peculiar conditions and provided with scales, shows costs as follows for three months:

Tons handled per day	450
Interest and depreciation	11.6 cents
Operation	2.8 cents
Maintenance	2.1 cents
Car storage	1.9 cents
Total cost per ton	18.4 cents

THE ROBBINS BELT TYPE.

Plants raising the coal on a continuous belt of rubber and cotton on an incline of about thirty degrees are coming into use.

The maintenance cost is reasonable, and in most situations it can be as readily fitted in as any other type. In some locations, where plenty of space is available, a better storage yard for coal cars can be provided with this than by any other type, as the receiving hopper can be placed a considerable distance from the storage bins in any direction. There are very few parts of this which can get out of order. The ordinary objection to this type, the expense of belt renewal, is only about 0.2 of a cent per ton, a comparatively small amount, which makes no appreciable difference in the total cost of maintenance.

Four belt conveyor plants, operating with ninety per cent of self-clearing cars, show average cost for ten months as follows:

Tons handled a day	280
Interest and depreciation	1.7 cents
Operation	2.7 cents
Maintenance (including 0.2 cent for belt renewal	0.5 cent
Car storage	4.4 cents
Total cost per ton	9.3 cents

One plant shows the following costs for a year's operation:

Tons handled per day	127
Interest and depreciation	3.2 cents
Operation	4.3 cents
Maintenance	0.6 cent
Car storage	4.1 cents
Total cost per ton	12.2 cents

Another plant for three months shows:

Tons handled per day	218
Interest and depreciation	3.3 cents
Operation	3.1 cents
Maintenance (Est.)	0.5 cent
Car storage	0.0 cent
Total cost per ton	6.9 cents

For large plants, where coal is delivered in self-clearing cars and an unloading hopper is used, tracks can be so arranged that cars can be handled by gravity, without the need of switch engines, decreasing the cost of operation.

A locomotive crane as an auxiliary for handling cinders, sand and coal in emergencies, is very desirable.

Although most roads do not now consider it necessary to weigh the coal accurately as delivered to locomotives, some plants are built with this provision. Storage bins, holding as much as one hundred tons, on scales, are used, or else auxiliary bins on scales, with a capacity of five or ten tons, are placed underneath the large storage bins. The use of scales is sometimes avoided with trestle plants by providing small auxiliary pockets in which the measuring can be done by volume. The scales add considerably to the cost.

With belt or bucket conveyors, the bins should be designed so as to prevent an accumulation of slack.

Slack coal in considerable masses, which is not moved for a long time, may cause spontaneous combustion.

If it collects, it will finally slide out in large masses, so that one engine may be furnished with a very considerable amount of it, in which cases the performance of trains is seriously interfered with. This trouble can be prevented by designing the bins with hopper bottoms and by placing the points of delivery into the bins directly over the points from which the coal is taken. The slack is then used as it is delivered. If this is not done, the slack will drop directly from the points of delivery, and large lumps will roll to the mouth of the chutes.

With some grades of coal, where run of mine or lump is used, it is necessary to provide means of breaking it up. Breaker bars can be either placed over the hopper, which will not allow any coal above a certain size to pass without being broken up, or else a crusher can be provided. The breaker bars deliver the coal in better condition, but are more expensive in operation.

Where softer grades of coal are used, it is important that the plant be designed to avoid breakage as much as possible.

The handling of sand and cinders is frequently attempted in connection with coaling stations, but, unless separate machinery is provided, they have not generally been successfully operated, due largely to the excessive wear caused by the cinders and sand on the moving parts.

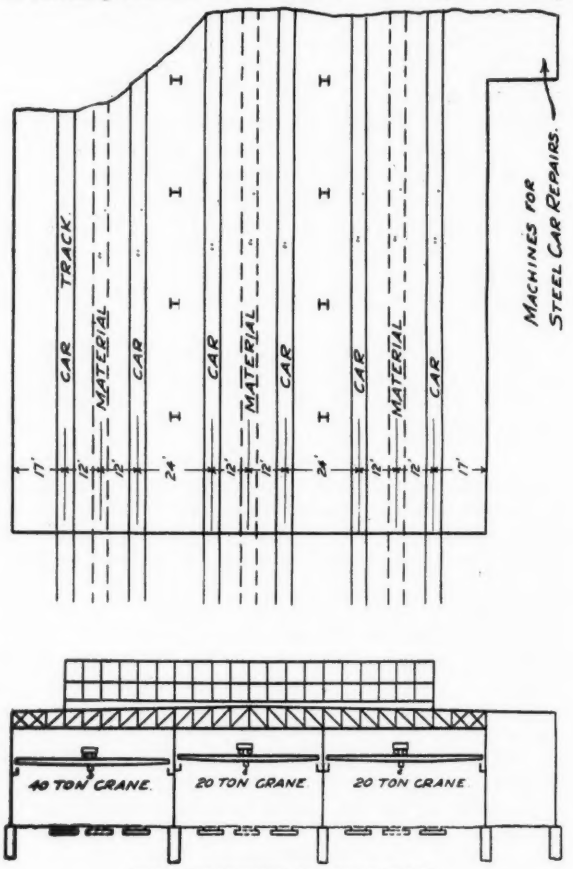
Some efficient method of fire protection is very desirable, many expensive plants having been destroyed by fire.

The recent and prospective increases in the cost of labor and timber and the demand for greater reliability of service tend to increase the desirability of having better coaling plants built of steel or reinforced concrete.

CONCLUSIONS.

(1). The present records of the cost of operation of coaling plants on nearly all roads are incomplete and of little value for comparison with each other.

(2) The cost items should include charges for interest and depreciation, charges for maintenance and operation (the cost of switching cars onto trestle should be included), and a charge for the use of cars for storage purposes.



SHED OVER FREIGHT CAR REPAIR TRACK.

(3) That plants must be reliable and not cause unnecessary delay to engines or cars.

(4) That provision should be made for fire protection, the avoidance of damage to the coal, and its delivery in the best possible condition.

(5) That the use of self-clearing cars should be made possible, and ordinarily it should also be possible to shovel from flat-bottomed cars.

(6) That storage for emergency purposes and fireproof construction are, in general, to be recommended, and in some cases duplicate machinery is desirable.

(7) That where self-clearing cars cannot be regularly obtained, either a locomotive crane or a trolley hoist, using a bucket of the clamshell type, is preferable to unloading by hand.

(8) That for a small terminal, the two-bucket hoist seems to have good points, where a deep foundation is not too expensive.

(9) That for larger plants, some conveyor type is desirable.

Review of Current Practice of Placing Sheds Over Freight Car Repair Tracks, with Results

Freight car repair work has, if possible, been increasing in importance during the past few years.

The tonnage capacity per car has practically been doubled in ten years, and the age of the wooden freight car is rapidly passing, and the steel car is taking its place. The tractive power of the locomotive has increased in about the same proportion in the same time; all of which has made it necessary to provide heavier cars, with heavier parts, making the cost of repair work by the old methods slow and costly when applied to the new cars.

As the cars have increased in capacity, so have the wheels, trucks and other parts increased in weight to such an extent that they can now be handled best by the use of power.

The rapid increase in the demand for freight cars has made it wise to hold them as short a time as possible waiting for repairs, and the shortage of labor and the increased rates of wages have all accentuated the necessity for using power wherever possible to increase the efficiency of the labor.

These and other considerations have convinced several railroad companies of the desirability of improving the facilities for freight car repairs.

An accompanying illustration shows a plan and a section of a building constructed about two years ago for this work. This building is of brick, with a steel frame and roof, and has ample light from "saw-teeth" roof construction, and it is comfortably heated by hot air.

One bay over two lines of cars is furnished with a forty-ton electric traveling crane, and the other two bays have twenty-ton cranes each. The forty-ton crane is used for handling loaded cars needing repairs, and all the cranes are used for raising car bodies, handling material and trucks and placing the car bodies on the trucks.

The building is equipped with compressed air and electric light, and it also has a plate furnace and the necessary machinery for repairing steel car bodies.

This building has not been in use long enough to furnish good comparative figures. The superintendent of motive power, however, is enthusiastic in recommending such an equipment for heavy repairs. (He does not yet recommend it for light repairs.)

The advantages are:

(1) A reduction in the cost of the work done, due to the use of power.

(2) A reduction in the cost of labor, on account of comfortable surroundings.

(3) A better class of labor can be had, due to continuous service.

(4) No loss of time due to bad weather.

(5) Night work can be done if necessary and full time can be worked in winter by the use of artificial light mornings and evenings.

Roadway

The committee submitted general specifications for a modern steam shovel for roadway construction which it believes will meet the requirements for which it is intended. The committee recommend the steam shovel weigh 70 tons, dipped capacity 2½ tons, steam pressure 120 lbs., clear height above rail of shovel track at which dipper unloads, 16 feet, depth below rail of shovel track dipper will dig, 4 feet. Number of movements of dipper per minute from time of entering bank to entering bank (3) chain hoist, cable swing, permanent housing for all employes, capacity tank 2,000 gallons, capacity coal bankers, 4 tons.

Necessary repair parts and tools on each steam shovel:

1 Hoisting Engine Cable or Chain,
1 Thrusting Engine Cable or Chain,
1 Swinging Engine Cable or Chain,
1 Set Dipper Teeth,
1 Dipper Latch,
12 Cold Shuts,
6 Cable Clamps,
1 U Bolt,
Duplicate of each Sheave on Machine,
Lot Assorted Bolts and Nuts,
Lot Assorted Pipes and Fittings,
Lot Assorted Water Glasses,
1 Blacksmith Forge with Anvil and complete tools,
1 Small Bench Vice,
3 Pipe Wrenches, assorted sizes,
3 Monkey Wrenches, assorted sizes,
6 Chilson Wrenches, assorted sizes,
1 Ratchet with assorted Twist Drills,
6 Round Files, assorted sizes,
1 Hack-saw, with twelve blades,
1 Set Pipe Taps and Dies.
1 Set Bolt Taps and Dies,
6 Cold Chisels, assorted sizes,
2 Machinists' Hammers,
2 Sledges,
2 Switch Chains,
2 Re-railing Frogs,
2 Ball-Bearing Jacks,
1 Siphon, complete,
1 Axe,
1 Hand Saw,
1 Set Triple Blocks, with rope,
2 Lining Bars,
1 Pinch Bar,
6 Shovels,
6 Picks,
1 Coal Scoop,
1 Flue Cleaner,
1 Fire Hoe,
1 Clinker Hook,
1 Slash Bar,
2 Hand Lanterns,
2 Torches,
Assortment of Packing,
Assorted Oil, in cans.

The committee also recommend for spread of jack arms (18 ft.) four pitmen, "T" rails on ties, ordinary length 6 ft., strap joint, standard gauge, and six yard dump car.

The committee recognizes the fact that the standard commercial flat car must frequently be used, and when this is necessary, especial care should be taken to cover certain important matters:

(1) See that car is strong enough for the purpose.

(2) Note that brake-wheels are in good condition, and in case material is to be plowed off, these must be placed at side of car.

(3) Care should be taken that stake pockets are in good condition and not spaced too far apart. Four feet apart in center of car and closer at ends is considered good practice.

(4) See that the stakes are strong enough to prevent accident or derailment of plow.

(g) Where dirt is dumped from trestle in fill for haul less than two miles, would you use light cars and light trestle or heavy cars and strong trestle?

15 replies favor light cars and trestles.

12 replies favor heavy cars and trestles.

Committee recommends light cars and light trestles.

Committee recommends handling cable with an auxiliary engine and drum. The machine should be able to develop 60 ton (pull) and will weigh about 28 tons. Steam cylinders 12x12. Diameter of drum, 4½ feet, which will permit four wraps of 1½ cable to be made.

Committee recommends that when raise is light, the center plow be used, but that side plows are more advantageous in making heavy fills.

The use of reversible plows are not recommended.

The committee desires to avoid mentioning names of special manufacturers and as many railroads build their own plows, the committee recommends a strong plow with trailer. It should not be less than 4½ ft. high and 36 ft. long. A 7-ton plow, as well as a 1½ in. diameter cable 1,200 ft. long, are recommended.

The committee recommends a two-arm spreader, 20 ft. spread, air pressure, 45 degrees limiting angle of wings, spreader should

RECORD OF STEAM SHOVEL NO .....

From .....M..... 190... to.....M..... 190...

Engineer ..... Cranesman.....

Material ..... Average Haul Stations.....

Locomotives No..... Cars No..... Size.....

Total Minutes Loading..... No. Cars..... Minutes Per Car..... No. Dippers....

Seconds Per Dipper..... Approximate Yardage.....

Total Minutes Moving ..... No. Moves..... Minutes Per Move.....

Minutes Delays Waiting for Cars..... Weather.....

Other Delays (Minutes)..... General Conditions.....

Total Hours Worked..... Hours Lost..... Total Hours on Duty.....

Cause Hours Lost.....

Shovel Moved and Ready.	Shovel Began Loading.	Delays Waiting for Cars.	Finished Loading and Ready to Move.	Time Loading.	Cars.	Dippers.	Time Moving	OTHER DELAYS. From.	OTHER DELAYS. To	Cause of Delay and Remarks.
Time.	Time.	Mins.	Time.	Mins	No	No.	Mins.	Time.	Time.	Mins.

ROADWAY, FIG 1.

deposit material 2 feet above and below rail.

In making embankments with trains on new location do not exceed 4 feet as vertical limits. A central core put up by teams and widened with shovel material not to exceed 4 feet. Committee does not recommend this method unless material can be cheaply borrowed from the side.

Committee recommends temporary trestle for fills over 4 ft. in height.

The committee calls attention to the ordinary graders, cableways, power scrapers, traveling cranes, suspended bridges and other types of mechanical appliances that might be used according to the conditions and the amount of material to be handled.

In making embankments with trains in present location of track under traffic, the committee recommends that where sand, gravel, or cinders can be used, under ordinary circumstances it might be economical to use this method where track is not to be raised to exceed 4 feet.

The lifting should be done gradually with no one lift to exceed six inches.

With reference to building a temporary track to one side to carry traffic and jack main track up vertically in place, the committee has in mind the length of track affected and the cost of the temporary track, but where traffic is heavy, would recommend this method where track is to be raised to exceed 4 feet.

The committee believes the method of throwing main track to one side and build trestle to be economical where track is to be raised to exceed 6 feet.

Other methods were asked for with six replies. Half of them suggested that a new temporary grade be built outside of the slope stakes for new embankment. The balance call attention to the practicability of first widening the embankment to its full width and as much higher as it can be made to avoid interference with traffic. Then build a new track on this new bank when old track can be taken up and bank raised. This method to be continued until final height is attained.

In regard to shrinkage, the committee recommends allowance for both vertical and width. Following is a letter written by the chairman in reply to an inquiry made by one of the members of the association:

"There appears to be no theoretical rules to decide what amount of allowance should be made for settlement of new embankments. Naturally the question is affected by the character of the foundation under the embankment and the character of the material making the embankment. The ordinary rule to use 10 per cent for shrinkage in height up to twenty-five feet and 15 per cent for banks over twenty-five feet in height, looks well in a book, but it would appear foolish to follow such a rule by

DAILY STEAM SHOVEL REPORT.

Steam Shovel No.....190...

Face of Bank..... Average Length of Haul.....

Details of Labor.		Hrs.	Rate.	Amt.	Cars Loaded.	Capacity in Yds.	No. Cars.	Yds per Car.	Total Yards.
S. S. Crew commenced wk....M.									
S. S. Crew quit work.....M.									
					Hart Convert	34'	80,000	35.6	side.....
S. S. Engineer						34'	80,000	25.3	cent .....
S. S. Fireman					Rogers	34'	100,000	29.3	.....
S. S. Cranesman						34'	80,000	29.3	.....
S. S. Watchman						34'	40,000		.....
S. S. Pitmen					Haskell &				
Car Repairers					Barker	40'	80,000	36.20	.....
Laborers									.....
Pumpmen					Ingoldsby	42'	100,000	42.4	.....
Total									.....
					Flats		80,000	29.3	.....
Spotting Crew com'd work....M.							60,000	22	.....
Spotting Crew quit work.....M.							50,000	18.3	.....
							40,000	14.7	.....
					Coal		60,000	36	.....
Engine No.							50,000	32.5	.....
Engine No.							40,000	23	.....
Engine No.					6 yd. dump cars			6	.....
Conductor					5 yd. dump cars			5	.....
Brakemen					Total				.....
Engine Watchmen					Loads left over from previous day				.....
					Average cost per cubic yard for labor				.....
					Average cost per cubic yard for material				.....
Total					Average cost per cubic yard for superintendence,				
Superintendence, etc.					plant, rent, etc.				.....
Grand Total					Total Average cost per cubic yard				.....

SUPPLIES, LOCOMOTIVES, CARS, PUMPS, ETC.

	Cts.	Pts.	Cost.		Cts.	Pts.	Cost.
Valve Oil				Coal Loco.			
Engine Oil				Waste C. C.			
Car Oil				Waste Wool			
Signal Oil							
Headlight Oil							
Coal Shovel				Total			

Kind of material handled.....

Character of work performed.....

Track Conditions .....

General Conditions .....

Weather .....

Delays.

	Hrs	Min.	Remarks.
Waiting for cars			
Moving Shovel			
Repairing Shovel			
Repairing Locomotive			
Other Delays			
Total Delays			

.....(Signature).

ROADWAY, FIG. 2.

making a 100-foot embankment 115 feet high. If you did so, the chances are that you would have to lower the grade before track was laid.

"I believe it a good practice to allow 10 per cent. in height with a limit of five feet, which I would not exceed except foundation is in a swamp.

"It is now conceded that the proper place to provide for shrinkage of embankments is in the width, and here there can be no limit. However, in your case, where you have good material and foundations, with very high banks, I would recommend:

"10 per cent increase in width of banks less than 25 ft. high;

15 per cent. increase in width of banks between 25 ft. and 50 ft. high; 20 per cent. increase in width of banks between 50 ft. and 75 ft. high; 25 per cent. increase in width of banks between 75 ft. and 100 ft. high.

"Possibly the latter is too strong, and that there should be a limit to increasing width as well as height. Banks will naturally settle and you want the material on the shoulders so that the track forces may keep the roadway built up to its full height and width."

Committee recommend 15 per cent. for black dirt, trestle filling as well as 5 per cent. raising under traffic; clay, trestle filling 10 per cent. clay, raising under traffic 5 per cent.; sand, trestle filling 6 per cent.; sand, raising under traffic 5 per cent.

The committee suggested three forms herewith illustrated, as well as the following instructions to submit blanks to show results of steam shovel work:

MONTHLY STEAM SHOVEL REPORT.

Steam Shovel No.....at.....Month.....
Average Face of Bank.....Average Length of Haul.....

General:

Number of days worked	
Average daily car output	
Average cubic yards per car	
Total cubic yards	
Average cubic yards per day	
Actual time worked by S. S.	
Time delayed	
Percentage of delays	
Number and kind of cars used	
Number and kind of engines	
Kind of material	
Character of work performed	
Track conditions	
General conditions	
Weather	

Labor:

	Total.	Per Day.	Per Yard.
Cost shovel service			
Cost train service			
Cost car repairs			
Cost dumping cars			
Cost of superintendence and plant rental			
Total cost labor			

Supplies:

	Total.	Per Day. Used	Per Yard. Cost
Valve oil			
Engine oil			
Car oil			
Signal oil			
Headlight oil			
Coal for shovel			
Coal for engine			
Waste C. C. and wool			
Total supplies			

Total:

	Per Yard.	Per Day.
Total cost labor		
Total cost supplies		
Total cost S. S. work		

ROADWAY FIG. 3.

(1) A daily report for the purpose of competition between different shovel crews through the medium of local advertising the result of each shovel track. Such reports are known to have an excellent effect on the unit cost of the work. (See Figure 1.)

(2) A daily report for local office use in reporting amount of work done with itemized costs. (See Figure 2.)

(3) A monthly report for general office use in reporting details for the period's operation. (See Figure 3.)

The committee calls the attention of the members to a paper on the subject of "Cost of Steam Shovel Work," as presented by Mr. John C. Sesser, formerly engineer of construction, Chicago, Burlington & Quincy Railway, Bulletin No. 81, November, 1906.

In reference to determining the size of waterways, the committee calls attention to Bulletin 75, May, 1906, in which the late H. W. Parkhurst presented an article, "The Requisite Waterway for Railroad Culverts." This subject is one of considerable importance, and on which there are many different opinions, and as the committee is not prepared to do it justice, would request that it be again referred to.

CONCLUSIONS.

(1) Your committee suggests the adoption of its recommendations of general specifications for a modern steam shovel for roadway construction.

(2) Would recommend the adoption of three blank forms to show the results of steam shovel work.

(3) If necessary to do so, recommend that the alternate specification to cover overhaul clause be printed in the "Manual of Recommended Practice."

(4) That no change be made in the widths of roadway as adopted by the association.

Iron and Steel Structures

The committee was officially requested at the last annual meeting to investigate and report upon the advisability of changing the desired ultimate strength of structural steel from 60,000 to 62,000 pounds per inch. Also as to changing the maximum phosphorus content in steel castings from .08 per cent. to .06 per cent.

This matter has been placed before the committee, and the individual comments of the members are that they are not ready at this time to make any definite recommendations. It is now put forth for discussion by the association.

As to raising the desired ultimate to 62,000 pounds, the assumed advantage is that we should get a stronger material at the same price. The disadvantage is that the upper limit of the range might be dangerously hard for the ordinary usage of the bridge shop. This argument gathers force from the fact that we are now using thicker material than what might be called the normal thickness for testing purposes. To insure that specimens from thick material shall show the desired figures under test, the stock must be higher steel than is needed for thinner material. Moreover, our test specimens are cut from the edges of plates, the material of which is considerably lower in hardeners than the central line of the plates. This feature was conclusively shown by Mr. C. L. Huston, vice president Lukens Iron and Steel Company, in an illustrated paper read at the annual meeting of the American Society for Testing Materials. He showed that a large portion of a steel plate (the central part—nearly three-fourths of its area) is much harder than the edges. These facts go to prove that the regular run of our metal is really higher in hardeners than our tests show.

Our specification is now formally accepted by the association and it is undesirable to shake it up again until there is some radical reason for doing so. In view of these considerations it would seem best to leave the figures unchanged.

As to lower phosphorus in steel castings: Phosphorus is undoubtedly a serious evil in steel, although it adds greatly to its fluidity when being poured into molds. With low phosphorus the metal must be at a very high temperature to fill the mold, and high temperature tends to cause trouble from gas bubbles.

It is claimed that soft basic steel does not work well in castings and hence the chemistry ought to be kept within the range of acid steel. Probably .06 phosphorus can be readily obtained, but for ordinary uses of steel casting .08 per cent

is sufficiently safe, while for gears and special uses .05 per cent should be specified.

Following this in the report is a varied discussion by different members, bringing out the points of advantages on both sides.

During the past year your committee has investigated and discussed the question of changing the desired ultimate strength of structural steel from 60,000 to 62,000 pounds, the advisability of lowering the phosphorous limit in acid steel castings from .08 per cent to .06 per cent the problem of making experiments to determine the dynamic effect of live loads on bridges, inspection of existing bridges and records of same and the classification and rating of existing bridges as to their maximum safe loading.

In the matter of change in specifications as above, the committee is not ready at this time to recommend any change.

On impact experiments, an instrument for measuring deformations under strain has been perfected by Professor Turneaure, and one has been built at the University of Wisconsin. Several satisfactory trial experiments have been made with this instrument, and the committee awaits the action of the association in regard to procuring funds for prosecuting effective work on this subject.

On inspection of existing bridges, data has been collected by a sub-committee showing the practice of a large number of the principal roads in this country and schemes for uniform practice discussed.

On classification of existing bridges, as regards their safe carrying capacity, much sub-committee work has been done and valuable discussions obtained. On this subject, as well as on impact experiments and inspection, your committee desires to report progress, but is not ready to offer a final recommendation.

Classification of Existing Bridges.

By A. J. Himes.

To determine the capacities of a miscellaneous lot of old bridges is a very complicated and difficult task. To do so in a systematic and intelligent manner, so that one may feel as confident of the results as in the case of a new bridge, requires a large amount of time and expense. The task demands the highest skill of the engineer, and in its successful achievement experience must play a larger part than in many other lines of work. But the guide of experience must not lead to an intuitive judgment because whatever remains ill-defined is very apt to conceal an error. The judgment should be the result of a clear analysis of all available learning and experience and should be applied deliberately and with conviction.

To approach the task with clearness and with the assurance of harmonious results, requires a preliminary consideration of all the factors which enter into the safety of the bridge. There is the material, its nature and original quality, its present condition of wear and corrosion; the design, which has to do with the style of construction, original loading, unit strains and details; the workmanship, which has to do with the degree of perfection attained in the execution of the design and the present state of preservation which covers the history of its service, accidents, repairs, alterations and general deterioration.

Only by having a thorough knowledge of the materials used in the past as well as the present can one weigh carefully the influence of that factor of strength. Wrought iron in its perfection is an excellent material, but it is not always perfect and its peculiar faults are at times apparent. The ease of cutting out old iron rivets, their frequently crystallized appearance, occasional laminations and streaks of cinder, hard spots discovered with a drill in working old plates, all remind us that the imperfections of man's work should inspire caution when judging the merits of a bridge whose history is unknown.

Steel also has its faults, and the great variety which has been used under different specifications and sometimes in a single bridge renders a full record of the mill inspection necessary to produce a faith that the material of a structure is better than the poorest steel known to have been in use at the time when it was built. Sometimes it is well to remove old eye-bars or other parts and by testing determine the condition and strength of the metal. Excessive hardness or crystallization should always arouse suspicion, and they are not uncommon faults.

To decide upon the capacity of an old bridge and one of which no records can be found, is a very delicate matter. There is always a desire on the part of the financial management for a rigid adherence to economy, usually coupled with a total lack of understanding of the case and with which a positive statement of any kind carries more weight than an attempted explanation of the difficulties. Is the bridge safe or not? is the question; and an answer "yes or no" is expected, while the engineer, who knows of many cases within his experience where bridges which by all the learning of the profession ought to collapse under the first train have persisted in doing their work for many years, who knows the weaknesses of the art, the uncertainties, the undiscovered defects which may exist, and who has a serious appreciation of his responsibility, may well think twice before announcing his decision.

In the last analysis, as human affairs are judged, the question will be asked: "Did he make use of all usual and available means to determine his result? Did he use due diligence and does his work conform to the prevailing customs and best practices of his time?"

Here, then, is the importance of the work we have in hand, to establish a custom, to say what are the best practices by which our profession is to be judged.

In order to put the matter before the committee in form for discussion, for study and revision, there is here submitted a scheme or program, a line of thought, on which the analysis may proceed. No unanimity of opinion can be expected in the beginning, but all considerations of economy, safety and harmony of railroad operation require that a standard practice shall be established, and it is hoped that herein a step is made toward that end.

In the beginning it must be recognized that there are types of structure and types of detail which vary in their elements of safety far more than the material used. These things, as well as quality of construction and state of preservation, must influence the permissible load and be considered at the same time and together with the unit strain.

A single unit strain of twenty thousand pounds has been selected for all material and all designs. It is believed that this is close to the maximum strain that can in any way be justified. It is below the elastic limit of all iron used for bridges and is not more than two-thirds of the elastic limit of the softer steels. It has been generally used by engineers of large experience in the maintenance of old structures and is undoubtedly safe when there are no flaws, either defects of manufacture or later injuries. This selection ignores the relative merits of different materials and must do so, for save the specific and heretofore unusual case of a bridge whose full inspection record has been preserved, there is no information adequate for any discrimination.

But while a single unit strain has been chosen for all cases, recognition is given to the fact that varying structures and conditions of loading produce different degrees of safety. These things, however, do not concern the metal itself, and the figure selected is that which should be safely carried at all times if applied without shock.

The conditions of loading commonly assumed for new bridges are supposed to cover extreme cases and may be wisely modified in the discussion of those already built. It is easy to avoid coupling two locomotives together, and, therefore, but one should be assumed at the head of the train. Wheel concentrations are

never realized and may well be ignored in certain structures. Impact, about which such varying ideas are held, has been used as employed by Cooper (see Association Bulletin No. 71, page 52) to cover the effect of a sudden blow due to derailment.

Before considering the several types of structure, it is well to review the possible methods of failure.

The rupture of any important bridge member requires work. Work is the product of force by distance, which involves time. To those familiar with the testing of full-sized members it is scarcely conceivable that one should give way under the passage at full speed of a heavy locomotive. A load equal to the ultimate strength would require some seconds to produce rupture. There are many cases where a locomotive has passed completely over a bridge that has failed under the train it was pulling. An electric railway bridge at Conneaut failed not long ago under a motor car which safely cleared the bridge. It was plainly a case where the bridge did not have time to fall down under the car.

But while no part of the bridge is likely to be strained to the ultimate limit by assumed conditions of loading, the force of a blow may greatly exceed that limit and be so great that a fraction of a second will suffice for failure. A shock is then most to be feared in a weak bridge.

The longitudinal forces due to the starting or stopping of a train, the bumping of freight cars caused by a sudden application of the brakes, the hammer blow of locomotive driving wheels, or a derailment, may afford such a shock.

All bridges in which the full load is carried directly to a single member, as a floor-beam hanger or a hip vertical, are peculiarly liable to destruction by shock. Strains are divided among the different members of a truss in proportion to the elasticity thereof, and where more than one path is possible, what might be an overload for one member becomes divided and may be safely carried by both. A case is authentically reported where a post was knocked out of a truss by an accident and the following train passed over the bridge in safety, the only support for one end of the floor-beam having been the iron stringers, with their riveted floor-beam connections acting as a girder of two panel lengths. In this case the strains surely did not travel in the path designed for them.

It follows that those types of structure which avoid applying the full load directly to a single member afford a higher degree of safety than exists where single members are so used.

Destruction may come from the wear and deterioration caused by excessive motion. The rubbing of counters, and floor-beam hangers, the rotation of pins, the working of joints, are examples. It is clear that these faults are peculiar to certain types of structure. Failures from this cause come slowly and may be forestalled by inspection and repairs.

The wearing of details is readily discovered by inspection. It is indicated by streaks of rust, cracking of paint, loosening of rivets, deflection, vibration and noise.

The safest type of bridge is the deck-plate girder. Such a bridge is not likely to collapse from overload and is less subject to the danger of shock than any other bridge. With a deck of ballast it is free from concentrated loading and impact and will stand the highest degree of overloading. Failure is not impossible, but it will come gradually and will furnish ample warning by loosening of rivets, cracking of paint and bulging of plates.

Next in safety is the through-plate girder. Its points of weakness as compared with the former being the floor-beam and stringer connections, the increased number of parts and the danger of blows to the girders in case of derailment. Used with a ballast floor, it may also be considered free from concentration and impact. Without ballast, an impact allowance of 25 per cent. is made in floor connections.

The riveted deck truss is classed next in degree of safety. Its floor system is of the simplest type. No part stands above the track to receive a blow from a train, and it should have a minimum of vibration. With a ballasted floor, concentration and impact may be neglected.

Riveted through trusses are next on the list. These bridges, even with ballasted floors, are more subject to abuse and should have an impact allowance. With subdivided panels, there is such a multiplicity of possible paths for strains to travel that there is small danger of collapse through failure of a single member.

Type of Structure.	Unit Strain.	Character of Loading.	Impact.
	Pounds.		
Plate girder, deck, ballasted	20,000	Uniform.	None.
Plate girder, deck, no ballast	20,000	Concentrated.	None.
Plate girder, thro., ballasted	20,000	Uniform.	None.
Plate girder, thro., no ballast	20,000	Concentrated.	25% on floor connections.
Trusses, riveted, deck, ballasted	20,000	Uniform.	None.
Trusses, riveted, deck, no ballast	20,000	Concentrated	25% on floor connections.
Trusses, riveted, thro., ballasted	20,000	Uniform.	25% on floor connections.
Trusses, riveted, thro., no ballast	20,000	Concentrated.	25% on members carrying direct strain.
Trusses, pin-con. deck, ballasted	20,000	Uniform.	None.
Trusses, pin-con. deck, no ballast	20,000	Concentrated.	25% on floor connections.
Trusses, pin-con. thro., ballasted	20,000	Uniform.	25% on members carrying direct strain
Trusses, pin-con. thro., no ballast	20,000	Concentrated.	25% on members carrying direct strain.

NOTES. The several types are arranged according to the degree of their security from failure.
Strains are to be calculated for one locomotive followed by a uniform train load.
The bending moments of stringers, floorbeams and plate girders are assumed to be resisted by flange section only.
Details should be well designed.
Corrosion and wear should be very small.

The pin-connected truss is placed last, and because of the differences of opinion which prevail concerning the comparative merits of pin-connected and riveted structures, it should be said that this has been written chiefly with reference to ordinary structures of less than two hundred feet span. The reasons why it seems less safe than the riveted type are because of its greater flexibility and vibration, the consequent wear of the parts and the greater chance of failure through rupture of a single member.

The table herewith presents the classification in condensed form. In it the types of structure are arranged in their order of superiority as determined by their freedom from opportunities for destruction.

Under character of loading by "uniform" it is meant that the engine load is to be uniformly distributed over the wheel base; by "concentrated" is meant that wheel loads are to be used.

In discussing the table the report continues:

For the first three types, the period of use under the conditions stated may be indefinite. For the remainder, the period of use should be limited, its exact duration to be determined by inspection.

The impact allowance does not conform to the specifications of the association, as that appears to be a refinement beyond the limits of error of this class of work.

The system proposed is intended to apply to regular traffic. Under such traffic, a frequent and rigid inspection will discover weakness before failure results and there need be little fear of accident. Good track, a reduction of speed, prohibition of stopping, starting or use of brakes, are precautions to be rigidly observed. It is considered that bridges which come within these limits, but show little or no excess of strength, require provision for early renewal. To say just how long they may be used is impossible. Their life at any time is to be determined by inspection.

For reasons already stated, failure is to be looked for in the details rather than in the body of the member. It is impossible to discuss the safety of a bridge without consideration of the details. Many very bad details have been used and if plans are not available they should be studied in the field.

The passage of an exceptionally heavy load is to be carefully guarded as unusual treatment and is most likely to develop a weakness.

Every bridge should be studied individually and treated according to its peculiarities. A trained inspector should be familiar with all its details and make his examinations at periods to be governed by its condition.

Very many conditions may exist which have not been mentioned and which may largely influence the decision. It is impossible to discuss every case, but the enumeration of a few defects that have come within the writer's experience may be of interest: A cast-iron trussed floor beam suffered a vertical crack near the hanger, so that all shear was carried by the truss rods. An inside top flange plate of a through plate girder cracked square across the flange. The material was steel. Both bridges remained in service. A heavy timber falling on an outside chord bar bent it badly. The bar was removed readily without force and replaced without interruption of traffic and without the use of false work. The bridge was a single track deck span of 325 feet. The chord bars in the end panels of through spans have been found perfectly slack, the thrust of the end posts being taken up by the masonry, and this condition existed where there were rollers under the pedestals. Top chord pins have been found channeled ⅜ inch by the pin plates. Sway rods have been broken repeatedly in skew deck spans where the second panel point of one truss was opposite the masonry bearing of the other truss. A locomotive backed into the end post of a partially open pin-connected draw span and destroyed the post without other damage to the bridge. The bottom chord of a pin-connected draw span was completely severed by a boat, but the truss was only slightly distorted and easily restored to service. A tower post of a pin-connected iron trestle of 30-foot and 60-foot spans was knocked from its masonry pedestal by a falling freight car. The car was in the middle of a train, but the trestle did not fall. The wreck was caused by a sudden application of the brakes and the train remained standing on the trestle. Iron floor beams with U-hangers and wooden stringers oscillate continuously under the passage of a train.

In reference to loads to be handled by bridges, Mr. C. D. Purdon, consulting engineer of the St. Louis & San Francisco railroad, has developed a system described by him in the Journal of the Association of Engineering Societies, Vol. 33, page 325, under the title "The Classification of Engines for Bridge Loading."

He calculates each bridge for Cooper's E-40 loading and determines its weakest part. He then by proportion finds that one of Cooper's series for which it is safe and assigns the bridge to that class. He next determines the relative position in Cooper's series of each class of locomotive in use, and by plotting on the same sheet the equivalent uniform load per foot for varying spans produced by each class and also by the loads of Cooper's series, their relative effects on the structure can be easily seen. The load curves of Cooper's series are thus made to serve as a scale with which to measure the capacity of a bridge to carry loads other than those of the series.

It is considered that the strains calculated from assumed wheel loads are somewhat fictitious, that the floor system always operates to distribute the load and that even pin-connected bridges never even approximate the theoretical assumption of hinged joints. It seems as though any load judiciously assigned to a place in the scale could be safely carried without a more refined calculation.

In conclusion the writer suggests that a concise history of each bridge (with references to the plan file) be kept and bound with others in a loose-leaf binder. The sheets should be about 8½ by 14 inches, with quadrille ruling. Such a history, if preserved for ten or fifteen years, would be of great value in deciding promptly questions which sometimes require weeks to settle. Then in order to put this information in the hands of the operating department, instead of permitting untrained men to use Mr. Purdon's diagram, he would rule a sheet in squares with a list of all stations on a district in the left-hand column and the same list arranged horizontally across the top. Then below any station at the top and opposite each station in the column, write the class of Cooper's series representing the maximum permissible load between those stations and also the span of the weakest bridge.

The work of the engineer's office would then be reduced to a determination of the position in the series of any proposed loading. All locomotives in regular service could be compared with the series by tabulation. Such a sheet would, of course, never be completely filled, but it would afford a means of recording the results of one's labor and in time would be of great value. Every decision would appear in the table and not be buried in the more or less accessible files of the office.

It is suggested that load curves for Cooper's series and a number of other common leads be printed for distribution, thus avoiding an unnecessary repetition of labor.

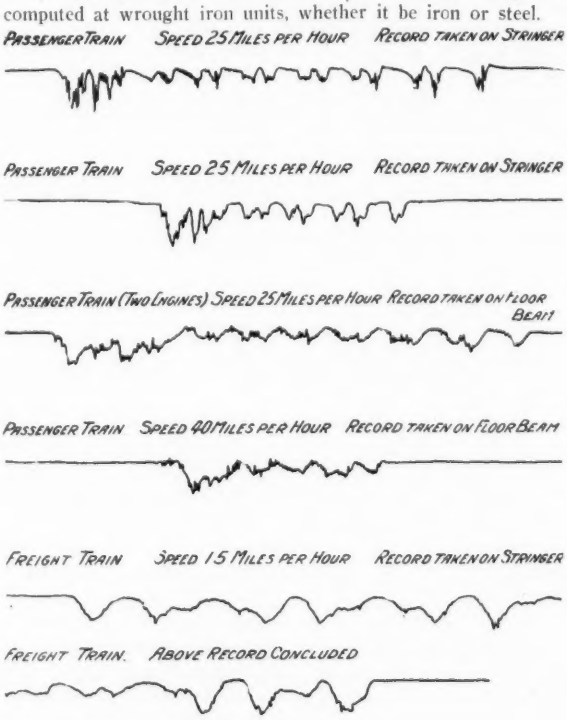
An Austrian railway ministerial order covered special regulations concerning existing railway bridges is abstracted in Bulletin No. 4 Vol. XX, April, 1906, of International Railway Congress.

In wrought or ingot iron bridges built before the adoption of this order, the maximum strain in iron or steel shall not exceed the units specified in the following table:

	When strains from vertical and centrifugal loads and from temperature effects alone are considered:	Pounds per Square Inch.
1.	Tension and compression:	
	Spans up to 100 feet	13,510
	Spans over 100 feet	13,077+434*l*
	Where *l* equals the span in feet:	
2.	Shear, except on rivets	9,960
3.	Shear, on rivets, in one direction only	11,380
	Shear, on rivets, in several directions	10,670
4.	Bearing on rivets	24,900
	When wind, lateral oscillation and brake action are considered as well as the above forces:	
5.	Tension and compression	17,780
6.	Shear, except on rivets	11,380
7.	Shear, on rivets	12,090
8.	Bearing on rivets	28,460

These units are about 25 per cent. greater than thost prescribed for new bridges. The loads to be used on existing bridges are two of the most unfavorable engines in use on the line in question, followed by a train of the heaviest loaded freight cars. On new designs the loads are typical. The live load strains are without impact and all existing bridges seem to be treated as if constructed of wrought-iron.

Reinforcing material for strengthening existing bridges is computed at wrought iron units, whether it be iron or steel.


PASSENGER TRAIN SPEED 25 MILES PER HOUR RECORD TAKEN ON STRINGER
PASSENGER TRAIN SPEED 25 MILES PER HOUR RECORD TAKEN ON STRINGER
PASSENGER TRAIN (TWO ENGINES) SPEED 25 MILES PER HOUR RECORD TAKEN ON FLOOR BEAM
PASSENGER TRAIN SPEED 40 MILES PER HOUR RECORD TAKEN ON FLOOR BEAM
FREIGHT TRAIN SPEED 15 MILES PER HOUR RECORD TAKEN ON STRINGER
FREIGHT TRAIN. ABOVE RECORD CONCLUDED
NOTE:- ALL RECORDS READ FROM LEFT TO RIGHT.

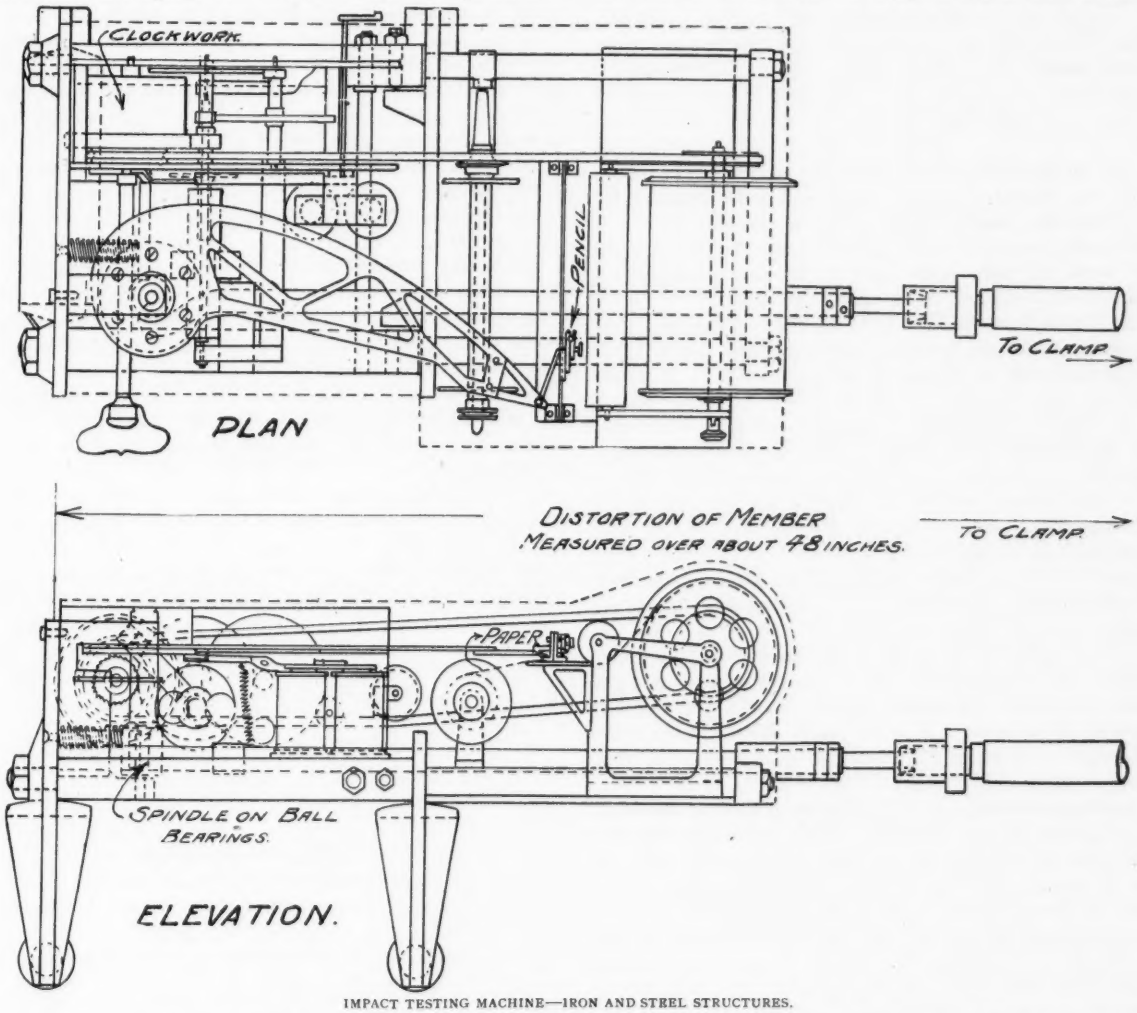
CURVES FROM IMPACT TESTING MACHINE IRON AND STEEL STRUCTURES.

EXPLANATION OF INSTRUMENT FOR MEASURING IMPACT.

By Prof. F. E. Tourneaure.

This instrument at hand is merely an autographic extensometer for recording the deformation of bridge members and multiplying that deformation by a factor of 80 or 90, and recording it on a moving strip of paper. It is clamped to an I-bar or angle bar, on any projecting corner of a member. There is another clamp also connected to the member at a distance of 3 or 4 feet or more, as desired. The two are then connected by a light rod, pipe, or something of that sort by means of a universal coupling. The deformation in that length of member is then recorded, multiplied by the factor of about 75, by means of a single lever. In the interior of the apparatus is a rod, running from this connecting rod to the short end of a lever, where there is a knife edge bearing. The long end of the lever is rigid (made of aluminum to be as light as possible), at the end of which is a pencil which will record its movement on a moving strip of paper. Experience with a similar apparatus in which the multiplication was much larger indicated that the point to be sought in the design of such an apparatus were not too great multiplication, very rigid parts, and light parts, so that the inertia of the moving parts would be as small as possible. I think we have accomplished this to a somewhat better degree than in the other type of machine, which has been used considerably, the Frankel instrument, where the multiplication is something like 140 or 150. Some tentative experiments with this apparatus indicate it will do better work on these short members, where the stresses vary very rapidly. It has been tried on 10-foot I-beam stringers, under speeds of 30 or 40 miles an hour, with quite satisfactory results. I am not sure that it would give such results on such short members under higher speeds, but on girders and members which receive their maximum load for a movement of train of 15 or 25 feet and upward, I think the result will be quite satisfactory and for a 30 or 40 foot plate girder the result will be reliable.

It is proposed in carrying out experiments of this sort to have 8, 10 or 12 such instruments attached simultaneously to the different parts of the structure. They can be connected electrically so that the papers can be started in motion simultaneously and then to move across the bridge a loaded train, whatever type of engine is selected, at different rates of speed. It is not proposed to make calculations of what the stresses ought to be, but to run a train at slow speed, 10 or 15 miles an hour, and take the stress developed as the static stress, and vary the speed of the train up to the maximum limit.



IMPACT TESTING MACHINE—IRON AND STEEL STRUCTURES.

The relation between the measured stress and the calculated stress is the question that can be taken up independently of the question of impact, but the question of impact can be got at rapidly for any structure provided we have an experimental train to be run over the bridge at any desired rate of speed. By having a number of instruments a pretty thorough test can be made on an ordinary bridge in a day's work, or at most in two days. A few diagrams of the results of the tentative experiments, as well as the plan and elevation of the instrument have been made for the committee and are herewith presented.

Wooden Bridges and Trestles

The following revised specifications were recommended for adoption by the committee on Wooden Bridges and Trestles, superceding those submitted in 1905 and revised in 1906 (Proceeding, Vol. 7, page 689; Railway Engineering and Maintenance of Way, April, 1906, page 120).

SPECIFICATIONS FOR WORKMANSHIP FOR PILE AND FRAME TRESTLES TO BE BUILT UNDER CONTRACT.

SITE.

1. The trestle to be built under these specifications is located on the line of.....Railroad, at..... County of.....State of.....

GENERAL DESCRIPTION.

2. The work to be done under these specifications covers the driving, framing, and erection of a.....track wooden trestle about.....feet long and an average of .....feet high.

GENERAL CLAUSES.

3. The contractor is to furnish all necessary labor, tools, machinery, supplies, temporary staging and outfit required. He is to build the complete trestle ready for the track rails, in a workmanlike manner, in strict accordance with the plans and the true intent of these specifications, to the satisfaction and acceptance of the engineer of the railroad company.

4. The workmanship is to be of the best quality in each class of work. All details, fastenings and connections are to be of the best method of construction in general use on first-class work.

5. Holes must be bored for all bolts. The depth of the hole and the diameter of the auger to be as specified by the engineer.

6. All framing shall be accurately fitted; no blocking or shimming will be allowed in making joints. All timbers must be cut off with the saw; no axe to be used.

7. All joints and points of bearing for which no fastening is shown on the plans, shall be fastened as specified by the engineer.

8. The engineer or his authorized agents shall have full power to cause any inferior work to be condemned, and taken down or altered, at the expense of the contractor. Any material destroyed by the contractor on account of inferior workmanship or carelessness of his men is to be replaced by the contractor at his own expense.

9. Figures shown on the plans are to govern in preference to scale measurements; if any discrepancies should arise or irregularities be discovered in the plans, the contractor shall call on the engineer for instructions. These specifications and the plans are intended to co-operate, and if any question arises as to the proper interpretation of the plans or specifications, it shall be referred to the engineer for a ruling.

10. The contractor shall, when required by the engineer, furnish a satisfactory watchman to guard the work.

11. On the completion of the work all refuse material and rubbish that may have accumulated on top or under and near the trestle, by reason of its construction shall be removed by the contractor.

DETAIL SPECIFICATIONS.

12. All piles shall be carefully selected to suit the place and ground where they are to be driven. When required by the engineer, pile butts shall be banded with iron or steel for driving, and the tips with suitable iron or steel shoes; such shoes will be furnished by the railroad company.

13. All piles are to be driven to a firm bearing, satisfactory to the engineer, or until five blows of a hammer weighing 3,000 pounds, falling 15 feet (or a hammer and fall producing the same mechanical effect), are required to cause an average penetration of ½ inch per blow, except in soft bottom, when special instructions will be given.

14. Batter piles shall be driven to the inclination shown by the plans, and shall require but slight bending before framing.

15. The butts of all piles in a bent are to be sawed off to one plane and trimmed so as not to leave any horizontal projection outside of the cap.

16. Piles injured in driving, or driven out of place, shall either be pulled out or cut off, and replaced by new piles.

17. Caps shall be sized over the piles or posts to a uniform thickness and even bearing on piles or posts. The side with most sap shall be placed downward.

18. Posts shall be sawed to proper length for their position (vertical or batter), and to an even bearing on cap and sill.

19. Sills shall be sized at the bearing of posts to one plane.

20. All sway bracing shall be properly framed and securely fastened to piles or posts. When necessary for pile bents, filling pieces shall be used between the braces and the piles on account of the variation in size of piles, and securely fastened and faced to obtain a bearing against all piles.

21. Longitudinal X-braces shall be properly framed and securely fastened to piles or posts.

22. Girts shall be properly framed and securely fastened to caps, sub-sills, posts or piles, as the plans may require.

23. Stringers shall be sized to a uniform height at supports. The edges with most sap shall be placed downward.

24. Jack stringers, if required on the plans, shall be neatly framed on caps, and their tops shall be in the same plane as the track stringers.

25. Ties shall be framed to a uniform thickness over bearings and they shall be placed with the rough side upward. They shall be spaced regularly, cut to even length and line, as called for on the plans.

26. Timber guard rails shall be framed as called for on the plans, laid to line and to a uniform top surface. They shall be firmly fastened to the ties as required.

27. Bulkheads shall be of sufficient dimensions to keep the embankment clear of the caps, stringers and ties, at the end bents of the trestle. There shall be a space of not less than 2 inches between the back of the end bent and the face of the bulkhead. The projecting ends of the bulkhead shall be sawed off to conform with the slope of the embankment, unless otherwise specified.

28. The work is to be completed in all its parts on or before.....A. D. 19.....

29. Payments will be made under the usual regulations of the railroad company.

The committee co-operated with American Society for Testing Materials for the purpose of preparing specifications of uniformity in the nomenclature of timber and its defects with the following results:

STANDARD DEFECTS OF STRUCTURAL TIMBER.

The standard defects included in the following list are mostly such as may be termed natural defects, as distinguished from defects of manufacture. The latter have usually been omitted, because the defects of manufacture are of very minor significance in the grading of structural timber:

1. SOUND KNOT. A sound knot is one which is solid across its face and is as hard as the wood surrounding it. It may be either red or black, and is so fixed by growth or position that it will retain its place in the piece.

2. LOOSE KNOT. A loose knot is one not firmly held in place by growth or position.

3. PITH KNOT. A pith knot is a sound knot with a pith hole not more than ¼ in. in diameter in the center.

Measurements which refer to the diameter of knots or holes shall be considered as the mean or average diameter in all cases.

4. ENCASED KNOT. An encased knot is one which is surrounded wholly or in part by bark or pitch. Where the encasement is less than ⅛ of an inch in width on each side, nor exceeding one-half the circumference of the knot, it shall be considered a sound knot.

5. ROTTEN KNOT. A rotten knot is one not as hard as the wood surrounding it.

6. PIN KNOT. A pin knot is a sound knot not over ½ in. in diameter.

7. STANDARD KNOT. A standard knot is a sound knot not over 1½ in. in diameter.

8. LARGE KNOT. A large knot is a sound knot, more than 1½ in. in diameter.

9. ROUND KNOT. A round knot is one which is oval or circular in form.

10. SPIKE KNOT. A spike knot is one sawn in a lengthwise direction. The mean or average diameter shall be taken as the size of these knots.

11. PITCH POCKETS. Pitch pockets are openings between the grain of the wood, containing more or less pitch or bark. These shall be classified as small, standard and large pitch pockets.

(a) SMALL PITCH POCKET. A small pitch pocket is one not over ⅛ of an inch wide.

(b) STANDARD PITCH POCKET. A standard pitch pocket is one not over ⅜ of an inch wide nor over 3 in. in length.

(c) LARGE PITCH POCKET. A large pitch pocket is one over ⅜ of an inch wide, or over 3 in. in length.

12. PITCH STREAK. A pitch streak is a well-defined accumulation of pitch at one point in the piece. When not sufficient to develop a well defined streak, or where the fiber between grains, that is, the coarse grained fiber, usually termed "spring wood," is not saturated with pitch, it shall not be considered a defect.

13. WANE. Wane is bark, or the lack of wood from any cause, on edges of timbers.

14. SHAKES. Shakes are splits or checks in timbers which usually cause a separation of the wood between annual rings.

15. ROT, DOTE AND RED HEART. Any form of decay which may be evident either as a dark red discoloration not found in the sound wood, or the presence of white or red rotten spots, shall be considered as a defect.

STANDARD NAMES FOR STRUCTURAL TIMBERS.

1. SOUTHERN YELLOW PINE. Under this heading three classes of timber are used (a) longleaf pine, (b) shortleaf pine, (c) loblolly pine.

(Note.—The committee of the American Society for Testing Materials divides "Southern Yellow Pine" into classes (a) and (b) only, and its classification is intended to be descriptive of quality, rather than of botanical species. Thus, shortleaf pine would cover such species as are now known as North Carolina pine, loblolly pine and shortleaf pine. "Longleaf pine" is to be descriptive of quality, and if shortleaf or loblolly pine is grown under such conditions that it produces a large percentage of hard summer wood, so as to be equivalent to the wood produced by the true longleaf, it would be covered by the term "longleaf pine."

2. DOUGLAS FIR. The term "Douglas Fir" is to cover the timber known likewise as yellow fir, red fir, western fir, fir, Washington fir, Oregon or Puget Sound fir, Northwest and West Coast fir.

3. NORWAY PINE, to cover what is known also as "Red Pine."

4. HEMLOCK, to cover Southern or Eastern hemlock; that is, hemlock from all states east of and including Minnesota.

5. WESTERN HEMLOCK, to cover hemlock from the Pacific Coast.

6. SPRUCE, to cover Eastern spruce; that is, the spruce timber coming from points east of Minnesota.

7. WESTERN SPRUCE, to cover spruce timber from the Pacific Coast.

8. WHITE PINE, to cover the timber which has hitherto been known as white pine, from Maine, Michigan, Wisconsin and Minnesota.

9. IDAHO WHITE PINE, the variety of white pine from Western Montana and Northern Idaho and Eastern Washington.

10. WESTERN PINE, to cover the timber sold as white pine coming from Arizona, California, New Mexico, Colorado, Oregon and Washington. This is the timber sometimes known as "Western Yellow Pine," or "Ponderosa Pine," or "California White Pine."

11. WESTERN LARCH, to cover the species of larch or tamarack from the Rocky Mountains and Pacific Coast regions.

12. TAMARACK, to cover the timber known as "Tamarack" or "Eastern Tamarack," from states east of and including Minnesota.

13. RED WOOD, to include the California wood usually known by that name.

14. OAK. Under this heading three classes of timber are used:

(a) WHITE OAK, to include White Oak, Burr Oak and Post Oak.

(b) RED OAK, to include Red Oak, Scarlet Oak, Black Oak, and all bastard oaks.

(c) CHESTNUT OAK, to include only Chestnut Oak.

"Shortleaf Pine" is inferior to the "Longleaf Pine" and is known by different colloquial names, with the exception of "Yellow Pine" which seems to be used interchangeably but more as a general term than as a name to separate the species.

"Loblolly Pine" is the name applied to the third division of "Southern Yellow Pine," and this species has a very wide range. Other common names applied are "Oldfield Pine;" "Bull Pine" (but the "Bull Pine" of the South must not be confused with the "Bull Pine" of the Northwest); "Bastard Pine;" "Yellow Pine" and "Swamp Pine." "Loblolly Pine" is, in some localities, made to include the "Cuban Pine" of the Southeast.

I hardly think that it is possible to make the term "Southern Yellow Pine" cover the three distinct classes of timber unless they are left as three classes, and if "Southern Yellow Pine" is to include the species that are commonly known as "Longleaf Pine" and "Shortleaf Pine" alone, then the "Loblolly Pine" should be put in a class of its own, separate from the "Southern Yellow Pine."

2. The term "Douglas Fir" is very widely known, being used from the Mississippi River westward, and almost invariably refers to the timber to which Douglas wished the name attached, "Douglas Spruce." The botanical name in itself means "false spruce" and therefore the name "Douglas Fir" can be properly used as referring to this much used and valuable timber, but to distinguish the tree firs of the West from the "Douglas Fir." It is recommended that the balance of the firs of the West be classified as "Western Fir," this term to include all of the true firs.

3. The "Norway Spruce" is correctly classified.

4. "Hemlock" is correctly classified as the hemlock of the Eastern states up to and including Minnesota.

5. "Western Hemlock" is very appropriately classified when it includes the hemlock west of Minnesota, ranging through Montana and Idaho to Alaska and along the coast range to California.

6. "Spruce" of the East is well known and properly classified.

7. "Western Spruce" should include all the spruces west of Minnesota, as previously stated, should be known as "Douglas Fir."

8. "White Pine" is well known and properly classified as including the pine of the Eastern states from Maine to Minnesota.

9 and 10. "Idaho White Pine" and "Western White Pine" are almost identical, very little difference in the wood structure and practically none in the lumber manufactured for structural purposes. But when this classification of "Western White Pine" is made to include the "Western Yellow Pine" and "Ponderosa Pine" or such species, it is wrong, for the "Western Yellow Pine" is distinct in every respect from "Western White Pine."

"Western Yellow Pine" would include the timber commonly known as "Yellow Pine" in California, Colorado, Montana, Washington and Oregon; "Bull Pine" in California, Washington, Utah, Idaho, Oregon, Wyoming, South Dakota and Colorado; "Big Pine" in Montana; "Longleaf Pine" in Utah and Nevada and "Western Pitch Pine" in Wyoming and Colorado.

There is such a difference between the "Western White Pine" and the "Western Yellow Pine" that I would suggest that the "Western Yellow Pine" be made a separate class and the "Idaho White Pine" be included under the classification of "Western White Pine."

Ties.

The committee reports progress for the year, and has endeavored to carry out the directions of the board.

One of the most important features committed to us has been the recommendation of standard sizes of ties. We recommended the adoption of a 7 in. by 8 in. by 8 ft. tie as the standard last year, but it was the opinion of the convention that there should be three standard sizes, corresponding to the classes of track already recognized by the association. The committee has reconsidered its recommendation accordingly, and if it could determine upon sizes with reference to strength and economy on maintenance only, would advocate for second and third class track, 7 in. by 8 in. by 8 ft. ties; and for the first class track, 7 in. by 9 in. by 8½ ft. ties. In view of the present condition of the tie supply and the possible future supply, it does not seem wise to adopt these sizes, and we recommend the following:

First class track, 7 in. by 8 in. by 8½ ft.
Second class track, 7 in. by 8 in. by 8 ft.
Third class track, 6 in. by 8 in. by 8 ft.

The committee has reviewed its specifications for the treatment of tie timber and finds no occasion to modify these as reported last year for consideration. We consequently now recommend their adoption as printed. It will be possible next year to supplement these by similar specifications covering one or two other processes. Then it may also be well to offer a specification for tar oil.

The committee has considered the proposed method for the analysis of creosote oils. There is a diversity of opinion regarding one or two features thereof. The committee is not clear as to the exact merits of the case, but is satisfied that the details are not entirely complete. The association has not adopted the proposed method, and we recommend no action be taken at this meeting, and that the committee be permitted to give the matter further study. No harm will result from the delay, and when we do recommend a method, we desire to have it as nearly correct as possible.

The committee was directed by the board to report upon the design and use of concrete and steel ties. An intelligent consideration of these must of necessity first consider the lessons to be learned from what has already been done. To this end information is requested of all members, as to where, when and with what result such ties have been used. We have only a partial report to offer on these lines, but it is hoped to supplement it next year by a review of the patents granted, the extension of our knowledge of the experimental ties in service and a discussion of the supposed desirable features which such ties should have. We say supposed desirable features, because the change from wood to other materials is so radical that we may need to entirely change our conceptions of what is desirable.

We may perhaps call attention to three elements very necessary to remember in the consideration of designs to replace wood ties:

First an efficient method of fastening the rail to the tie. This is a problem present with the wood tie also, if we consider the life of the tie. When we get away from the barbarous spike, we may perhaps get a connection which will be equally efficient with concrete ties as well.

Second, the requirement of a considerable measure of elasticity in any tie. We will always find a tendency of the ballast to become unstable, track to become center bound, and the wooden tie has met the condition because it is elastic. Neither the steel nor concrete tie offers the same elasticity, and will require greater care in track surfacing and maintenance.

Third, no metal tie has yet been designed that offers a satisfactory method of insulation, and this, of course, is a serious objection in view of the rapid increase in installation of block signals. It will be found necessary, doubtless, to use fiber as an insulating material, and it wears out so rapidly, that it will be a source of considerable trouble and expense to attempt to maintain insulating pieces on each tie. Concrete is almost an insulating material and it will probably be practicable to design a concrete tie that will overcome this difficulty. On the other hand, the construction of such a tie will require a great deal of care to prevent contact through the metal reinforcement.

The following is the report made to Mr. J. W. Kendrick, second vice-president of the Atchison, Topeka & Santa Fe Railway System, on Reinforced Concrete Ties, by Mr. E. O. Faulkner in November, 1904:

HARRELL TIE.

This was perhaps the first type of reinforced concrete ties used in America. Thirty were inserted in the Pennsylvania company's track in 1899 near the Union station, Chicago, the concrete being moulded around a truss of one-inch rods put together like a trussed brake beam. From first to last they were in service about seventeen months, the last tie being taken out in the fall of 1900. Shortly after they were first laid, single ones had to be removed, and this continued at intervals until all were taken out. Some broke in the middle, others gave way at the fastenings or under the track rails, so that toward the end, oak ties had to be sandwiched between them to help out. Later on Mr. Harrell made a number under what he claims to be a better pattern so far as track fastenings, etc., are concerned, and ten were placed in a switch track of the Western Foundry and Steel Company at Hegewisch, Ill., in August, 1901. Three have since been removed on account of a car derailment breaking them; the rest are still in service in good condition, but being in an industry side-track, there is no strain or service test, and under these conditions they should last for many years.

KIMBALL TIE.

This consists of two concrete bearing blocks shaped like a pole tie, each three feet long, nine inches wide, and seven inches thick, joined by two three-inch channels two inches apart placed back to back and moulded in the concrete, the bearing of the rail being taken by a cushion block of white oak, three inches thick, nine inches wide, and eighteen inches long, secured to the concrete base by bolts, the track rail being spiked to these blocks in the usual way and elm plugs set in the concrete to take care of the additional length of spikes.

Two were inserted in the Pere Marquette track at Saginaw in 1900, the blocks being held together by a piece of scrap rail; later, one was taken out and sent to the Roadmasters' convention in Milwaukee in the fall of 1901. It was put in the track in one of the local yards, and has since been lost sight of. The one still in service at Saginaw I found in good condition, excepting that one of the cushion blocks was badly cracked and

would soon need renewing. Before being used these blocks were treated with avenarius carbolineum. There was some rust on the old rail connecting the blocks, but nothing to hurt. Two others were inserted in the Saginaw yard in the fall of 1901, but were afterward taken out, though for what reason I could not learn. Eight more were put in the main track at Saginaw; these I found still in service and in good condition, some of the cushion blocks being somewhat sun checked; on removing the ballast from one or two ties I found very little rust on the connecting bars, the spikes were holding all right, and the ties looked well, but the test is not in sufficient numbers to warrant any practical conclusion. The ballast was gravel, and there were no cracks in any of the concrete blocks. Another tie was laid in the Port Huron yard in 1902, but no one knows where it is, or what has become of it. Two were laid in the Walkerville yard, and two near Pelton, Ontario, in September, 1903. I am told a derailment occurred on the yard ties, the wheels passing over the wooden cushion blocks without damage, excepting that some slivers were broken off where the first wheels struck them. Ten were also furnished the Nickel Plate in 1903, eight of which were laid east of Euclid Avenue Station, Cleveland, and two broken. I did not look up any of those inserted in 1903, as the time is so recent. There were thirty furnished the Grand Rapids Electric Railway for street car use, also one to the Detroit Electric Railway, which was put in at Gross Point. In 1902, 3,400 feet of the Pere Marquette track in Jefferson Street, Bay City, was laid with these ties without the connecting channel bars, the two blocks being laid in cement up to the level of the top of the rails. This piece of track has been widely advertised, and is in good condition; but where railway tracks are laid in cement and in paved city streets it can not be considered a test, so far as concrete ties for ordinary use are concerned.

ALFRED TIE.

This is one designed by the then chief engineer of the Pere Marquette. Fourteen were put in near the Kimball ties at Saginaw, Mich., in November, 1902, as an experiment, and all removed early in 1904 on account of breaking between rails, the design being faulty. Nine of a new pattern were inserted in the same place in the summer of 1904; of these one is broken close to track rail and several others already show signs of rail cutting, there being no cushion or protection between the base of the rail and the top of the tie; one has cut in one-eighth of an inch in three months, others nearly as much. Ten were laid in September, 1904, at Wixon water tank, where engine fires are cleaned, and wooden tie destroyed by cinders. These ten are said to be in good condition; it was dark when we passed, so that I could not see them personally; 214 more were laid in a sidetrack opposite Saginaw passenger depot in October, 1904, and immediately after laying them a ditch for a drain pipe was dug parallel to the track, within six inches of ends of ties. Of 87 alongside the ditch, 56 were cracked or broken, some in two or three places, and of the remaining 127 away from the ditch, one was broken close to inside rail. The ditch extended for some distance, where there were wooden ties in the same track, but none of these were damaged by reason of its location.

THE BURBANK TIE.

The reinforcement consists of an iron plate and a twisted bar of iron, bent at each end and welded to tie plates, which rest on wooden blocks and support the track rail. I was told there were 147 in the Hecla Mining Company's track, near Bay City, Mich., and two in the Hecla Belt Track at one of the crossings in the outskirts of the city. I could not go personally to the mining track, but sent another man, in order to learn how the ties looked; he has since advised me that he could not find a concrete tie in any mining or belt track owned by the Hecla Company, excepting the two spoken of, and these I found myself so badly broken after three months' service of switch trains that there is no question about the design being defective.

HICKEY TIE.

The reinforcement here consists of 7½ ft. of scrap track rail imbedded in the concrete; outside of this the other features of the tie have been changed from time to time as defects developed. First, the rail fastenings were improved, then it became apparent that on account of track rail cutting into the concrete, some protection had to be furnished, and a tie plate was tried. This has proven insufficient for the purpose, and Mr. Hickey now says a larger cushion of metal or wood must be placed between the rail base and the tie to prevent rail cutting. He has a number inserted in St. Thomas Yard (Ontario), also ten at Kingsmill, east of St. Thomas, in Michigan Central main track, under heavy service, and six at Taylor; in all between 35 and 40 ties, most of them having been in over two years, and one, still in good condition, three years. The greater portion are more or less cracked, and some broken, but Mr. Hickey says he will keep on experimenting, and hopes yet to be successful. He is the general roadmaster of the Michigan Central Company's lines in Canada. No derailment has occurred so far on these ties.

BRUNSON TIE.

The reinforcement here consists of some small strips of iron surrounded by concrete, wooden plugs being moulded in the concrete in which to drive the spikes, the track rail resting directly on the concrete. Nineteen of these were laid in Chicago Junction Railway stock yard tracks in September, 1904, near Forty-first and Halsted streets, Chicago. Two months after service I found cracks between the rails in fourteen out of the nineteen, some being cracked in two places. The rail was also beginning to cut some of them, especially joint ties. Nothing but slow switch train movement passes over them, and while this is heavy, it can scarcely be said that the test is sufficient to establish the value of the tie. No derailment has yet occurred on any of them.

SEELEY TIE.

This was a concrete tie without any reinforcement whatever, the only iron used being the bolt going through the concrete for rail fastenings. Ten were placed in the tracks of the Toledo Terminal Railway in August, 1903, and the superintendent informed me that they were all taken out again in less than two weeks on account of their breaking, and falling to pieces. Six or eight were also put in a sidetrack on the Lake Shore & Michigan Southern Railway at Air Line Junction, Toledo. I did not go to see these, as the roadmaster said they were badly broken, and would soon come out, adding further that if they had been in main track they would have been removed long before this.

COLORADO & SOUTHERN RAILWAY TEST.

In the summer of 1901 the officials of the Colorado & Southern Railway had three ties made and put in their yard at Argo, near Denver, the reinforcement in each tie consisting of three steel strips ½ in. thick, 4 in. wide and 8 ft. long. These ties were broken beyond further use in the spring of 1902 by an engine truck derailment, there being no protection on the outside of the tie to withstand any such shock.

AFFLECK TIE.

The reinforcement here consists of a piece of angle iron imbedded in the concrete, with a slight groove for rail seat, in which a wooden shim can be placed if desired, the rail being fastened to the tie by bolts coming up from the bottom. One was placed in a sidetrack at Dune Park, Ind., on the Lake Shore & Michigan Southern, in September, 1903. It is cracked in several places, but in view of its location, is still considered safe. In March, 1904, fifteen more were put in at Chesterton, Ind.,

but as they were not entirely satisfactory to the maker, he took them out and put fifteen others in in June, 1904. These are still in service, but are all cracked a little. They are also in sidetracks, as the Lake Shore & Michigan Southern officials do not consider it advisable to place them in the main line. The roadmaster says that so far, and as located, they have given fair satisfaction.

The Pennsylvania Lines west of Pittsburg are also testing this same tie, eighty-seven out of an order for one hundred being placed in their main line at Emsworth, Pa., in October, 1904. I examined these with the roadmaster a month later, and found six marked for removal before the close of the month, and another one has a broken end. They are on broken rock ballast in a track where heavy traffic and fast trains are continually running over it, the conditions being evidently too severe for the tie in its present shape.

THE BUHRER CONCRETE TIE.

The reinforcement of this tie consists of one-fourth part of a thirty-foot scrap rail inverted so that its base acts as a surface for the track rail, the rest of the reinforcement being heavily imbedded in concrete somewhat in the shape of a hewn tie, at the bottom, the rails being fastened to the tie by clips. There are 3,222 of these in service on a number of roads, viz.: Ann Arbor, 77; Lake Shore & Michigan Southern, 2,095; Pennsylvania Lines West of Pittsburg, 350; Lakeside & Marblehead, 550; Lake Erie & Western, 20; Chicago & Northwestern, 15, and Sandusky Water Works Company's track, 115. Of these, 40 were inserted in 1902, and so far there are only two failures; 707 were inserted in 1903, of which nineteen failures have been reported; and 2,415 were inserted in 1904, of which nearly all the failures are on the Pennsylvania Lines. This is the most successful of all the concrete ties I have seen, and under favorable conditions it certainly makes a fine looking track. I saw marks of a freight car (said to have been loaded) derailment at Milwaukee, the wheels of one truck having passed over several of these ties without damaging them in the least, and I was told of one or two other instances where derailments had occurred, no damage being done to the ties.

In four out of the six roads the ties were in gravel ballast, and no exception could be taken either as to the appearance of the track or the condition and service of the ties. On the Lakeside and Marblehead there are 550 ties inserted on a twelve degree curve in their yard at Danbury, Ohio, and this piece of track has been widely photographed as evidence of the success of this type of reinforced ties; it is certainly hard to beat, but every condition is favorable, and the ties have only been in service one winter. On the sixth road (Pennsylvania Lines West) it was reported their experience of concrete ties had so far not been satisfactory, and they did not propose at present to further extend their experiments in this direction. They have the Affleck (before mentioned) and the Buhrer ties. Of the latter, 248 were furnished in December, 1903, for insertion in their main line track at Emsworth, Pa., which were all put in by March, 1904. In June of same year 100 were replaced, and on November 19th following I saw a car load of new ones standing on one side track to replace broken ones. Including this car load it made 469 received since December, 1903, with 116 good sound ties in track in November, 1904, and a balance of seven remaining in reserve. Mr. Buhrer explained that in the first lot of ties shipped, the concrete in nearly all of them had frozen before it set, and they should never have been used. I can only account for the failures here by the fact that the rock ballast is so rigid as not to conform or give way to the movement of the ties when trains are passing over them, while the gravel ballast does, as I noticed this very clearly while on the Lake Shore & Michigan Southern. These are the only failures of the Buhrer ties worth mentioning, yet if "the strength of a chain is no greater than that of its weakest link," the failures of these ties in rock ballast and under heavy service must materially limit their value, irrespective of success under more favorable conditions.

CHICAGO, BURLINGTON & QUINCY RAILWAY TEST.

The engineering department of the Chicago, Burlington & Quincy at Chicago is engaged in a series of tests of reinforced concrete ties, having placed a number in a sidetrack at Hawthorne near Chicago about two months ago. The time is yet too recent to prove anything, but as the officials are proceeding in a careful and practical way, the result should go far to establish the possibility of ultimate success in reinforced concrete ties. I believe, however, they will yet have to make further changes in their design to accomplish this.

ULSTER & DELAWARE TEST.

A number of reinforced concrete ties were placed in the Ulster & Delaware track near Rondout, N. Y., in the summer of 1904, on account of the satisfactory service of one tie made and inserted in May, 1903. Tie plates eight inches by nine inches, one-quarter inch thick, are set in the concrete and support the track rails, which are fastened by bolts coming up from below the reinforcement; this latter consists of a piece of angle iron set in the concrete, the edge coming within ¼ inch of the surface. The first derailment on these ties will severely test them as there is no support for the corners. They weigh 450 pounds each.

There are two or three makes of concrete ties beside those mentioned which have been put into service on a few other roads during the past summer, but as the locations were somewhat scattered and the experience too recent to expect any result, I did not visit them.

REINFORCED CONCRETE TIES ABROAD.

If there is one continent more than another where we might expect to find concrete ties, it is in Europe, where wood is scarce and costly, but so far as I can learn only three tests have been made abroad up to the present time, and they are as follows:

SARDA TIE.

The reinforcement here consists of five metal plates placed vertically in a mould, held by thin bars or wires, and cement poured in around them. Four were inserted in October, 1900, near Bordeaux, and in the summer of 1902 one hundred more were laid, a slight change being made in construction so that rail fastenings could be replaced without damaging ties. Felt tie plates one-fifth of an inch thick were placed between tie and rail to reduce the shock, but within a year these had worn so that they could not be found. The greatest rolling weight was 14 tons on a single pair of drivers. The weight of the tie was 308 pounds, and the cost in our money $2.80 each. Some of this make of ties were also inserted in the Tramway Company's track at Perpignan, France, and also some in the main track of the Northern Railway of Spain, but no reports are obtainable as to results. The chief engineer of the French State Railways says the experiment is too recent for definite conclusion; and that as the usual life of wooden ties is fifteen years, a long time must elapse before conclusions can be reached as to whether cement is superior to wood in its power to resist shock, atmospheric changes, and other conditions, and further that so far as economy in track labor or material is concerned, none will be effected unless the cost of concrete ties can be materially reduced.

The Voiron St. Beron Railway (one-meter gauge) has been experimenting with a reinforced concrete tie consisting of three trusses of steel (18½ pounds), a plug of hard wood being imbedded in the concrete to hold rail fastenings. The weight of the tie (length 5 feet and 11 inches) is 232 pounds, and a layer of wood or felt is placed on top of the ties under the rail to lessen vibration. Sixty were inserted in March, 1903, at Revol, and at another place a stretch of track has concrete ties alternating with ordinary wooden ones. This gives no test worth anything, but in April, 1904, all were said to be in

perfect condition and the company were laying 250 more.

In Germany, a section of the State Railways near Briesen is laid with reinforced concrete ties in main and side tracks, under heavy traffic. The rails are fixed to the tie by an automatic locking device in which the grip between the tie hooks and the rail increases in proportion to the weight of the rolling load, the tie hook releasing its tight grip of the rail as soon as the train or car has passed over it, the claim being made that this action gives an elasticity to the roadbed necessary for economical maintenance of equipment. The ties were laid in September, 1897, and are said to be still in good condition.

In Italy on the Adriatic Railway experiments have been under way for some years, so that in 1900 a number of ties were put in service at or near Ancona, and according to latest reports were giving good service; this is very general, but is all the information I can get. Tie weighs about 300 pounds and costs $2.30.

On the French Railways in Cochin China, a number of concrete ties are said to be in use, having an inverted T section with an enlargement of the stem upon which the track rests (practically an I beam), but the number said to be in service is so large that I would not care to quote the statement without better authority, which is not available just now.

The following additional data has been obtained by the committee from other sources:

THE PERCIVAL TIE.

This is a reinforced tie of concrete and bars of iron, the section of tie being somewhat trapezoidal, except that the difference between faces is greater than in the Buhrer tie.

The fastening of the rail is by a screw spike into babbitt sockets poured in the concrete at the time of manufacture. The rail rests on a block of gum 9 inches by 15 inches by 2¼ inches, which forms a cushion and relieves the concrete from the severe action of the metal rail of limited section which would readily work into it.

A test of these ties in a road of heavy traffic has shown good results for two months. It is not possible yet to tell what the value of the tie will be.

THE CHENOWETH TIE.

This tie is a simple bar of concrete of the same size and uniform section as the usual wooden tie, the reinforcing material being a winding woven-wire sheet, wound in circular manner. The wire used is No. 16 with a ½-inch mesh.

The rail is supported upon a shim of wood acting as a tie plate, through which bolts are set with threaded top. The bolts are set in a similar manner to stone bolts. The clip is used to fasten the rail in place, in a manner similar to the method used in other types of manufactured ties. The ties have been in only a short time, and no results are yet manifest.

TREATED TIES.

However interesting the investigation and discussion of the substitutes for wood ties may be, there can be no question but that the thing for us is to hold on to the good things we now have, and make the best possible use of the wood tie while we have it. Few subjects are or should be of greater interest to railroad officials than the question of the actual results of the preservative treatment of ties. The use of such ties is constantly and rapidly increasing and the disposition of those using them is to feel greater confidence in the results, and a greater willingness to invest more money therein. The benefits of treatment are pretty nearly proportional to the amount expended thereon.

The history of treated ties to date is about as follows:

PENNSYLVANIA LINES WEST OF PITTSBURG.

Previous reports have given the results of the experimental ties laid at Kosciusko and Hanna, Ind., consisting of 200 Burnettized tamaracks and 200 untreated white oaks, laid in gravel ballast; at the first resulting in an average life of 8.8 years for the tamaracks, and 9.2 years for the white oaks; and of 200 burnettized hemlocks and 200 untreated white oaks in rock ballast, at the second; resulting in an average life of 9.1 years and 8.4 years, respectively.

Besides the above tests, which terminated two years ago, considerable numbers of ties of various kinds treated by the same method have been used on both the N. W. and S. W. Systems. The records of results are by no means complete, but Mr. Trimble, Chief Engineer of M. of W. of the N. W. System, under date of December, 1906, furnishes the following:

On the Western Division 9,937 burnettized beech ties were put in track in 1901 and 13,835 in 1902, all of which were in service January 1st, 1906. Of burnettized red oak, 135 were laid in 1897, of which 74 per cent were in service after eight years; in 1901 there were laid 5,309 similar ties, of which all but one were in service after four years. Of burnettized hemlocks, out of 11,393 laid in 1896 and 1897, there were still in service 78 per cent after eight years; from 713 laid in 1898, in service 92 per cent after seven years; from 2,048 laid in 1899, all but 13 still in, after six years; and of 521 laid in 1900, all still in after five years.

On the Chicago terminal division, of burnettized hemlocks, there were laid in 1896, 698 ties, of which there remained 100 per cent. after nine years; in 1897, 3,499 ties, of which there remained 76 per cent after eight years; in 1898, 275 ties, of which there remained 100 per cent. after seven years; in 1899, 1,000 ties, of which there remained 100 per cent after six years.

On the S. C. & S. R. R., of the same ties, 1,287 were laid in 1897, of which 70 per cent remained after eight years. The ties above were all treated by the zinc tannin process.

DULUTH & IRON RANGE RAILROAD.

In 1891, this road put in track 85 white pines, 85 tamaracks, and 86 Norway pines, all treated by the zinc tannin process. Reports of the condition of these ties have been reported from time to time. Under date of October 19th, 1906, Mr. Robert Angst, Chief Engineer, writes:

"We still have in track 45 white pines, 68 tamarack ties, 79 norway ties. We have not taken out any of the ties since they were replaced in the track in 1895. The rail is cutting into the ties pretty badly, most of them over one-half inch. Otherwise the ties are in pretty good shape. I do not think we will have to take any of them out for two or three years.

"These ties are on a maximum grade at the summit of a long pull, and the cutting under the 80-pound rail has become more marked with the increased number of steel ore cars of 50 tons capacity and the putting into service of a number of 170-ton consolidation engines. These engines, like all consolidation engines, have a large unloaded space between the front axle of the tender and the rear driver, and I suspect that the uplift of the rail between these two points which travels with the locomotive, is largely to blame for this cutting, as the sharp reverse vertical curve in the rail close to the rear driver has a tendency to rock the tie or cause the rail flange to cut into the shoulder."

The replacing in track refers to relaying due to change of grade, at which time some of the ties were broken by dynamite, used in taking up the track in the winter.

CHICAGO & NORTHWESTERN RAILWAY.

During the spring of 1906, a few treated hemlock ties were found in the track between Mayfair and Evanston, Ill. As it was known these ties must be very old, inquiries were made to ascertain when and how they were treated. It was found the Chicago Tie Preserving Company had treated 5,934 hemlocks and 2,393 cedars by the zinc tannin process, in the late fall of 1888. The hemlocks received 0.22-pound and the cedars 0.48-pound of dry zinc chloride per cubic foot. Mr. E. C. Carter, Chief Engineer, writes (September 14th, 1903):

"Of the 5,934 hemlock ties sent to H. G. Burt, West Chi-

cago Shops (40th St.) no definite record is obtainable. It appears certain, however, that a number of them were laid in main track of the Galena Division about one-half mile west of Dixon, and that they were taken out about six or seven years ago. No record of their condition was made at that time. The balance of these ties, it is supposed, were placed in track north of Mayfair on Chicago Cut-off, but no record can now be obtained.

"Of the 2,303 cedar ties sent to J. B. Berry at Milwaukee, 875 only can be located; these are under tracks in the Milwaukee train shed and in good state of preservation, though badly worn by traffic, and for that reason require replacement. The situation of these ties under cover—being planked over as well as under roof and laid in ballast well drained—is, of course, an exceptional one, and calculated to prolong the life of any tie; but I believe, however, their present good condition is due in part to the treatment they received."

A. T. & S. F. RAILWAY (LINES EAST OF ALBUQUERQUE, N. M.).

This road has laid up to January 1st, 1906, burnettized ties to the amount of 13,708,467. Records of removal prior to 1897 are lost, but since that time the average life of all ties removed on account of decay has been 10.62 years. Of the ties laid in 1885, 4,693 were taken out in 1904 and 4,633 in 1905. In 1905 there were laid 2,192,027 treated ties and 93,888 untreated ties.

CHICAGO & EASTERN ILLINOIS RAILROAD.

This road has been using ties (principally red oaks) treated with zinc tannin since 1899, the total number laid to January 1, 1906, being 1,337,413. The total number removed to the same date has been 6,118, of which 75 per cent were taken up because of changes in track and track taken up and were probably relaid; wrecks, 14 per cent; burnt, 5 per cent; the balance, 316 or 5 per cent of the renewals, were taken out as rotten, broken and for unknown causes. If all of these had come from the 1899 ties and were all removed because of decay, 94 per cent would still be in service after six years.

The Southern Pacific road continues its reports of service received from treated ties, although unfortunately those for the year ending June 30, 1906, for the Pacific System, were lost in the San Francisco fire. The report for the Atlantic System shows 34 per cent of the ties laid in track, 14 years previously, to be still in service; 34 per cent also of those laid 13 years previously; 46 per cent of those in track 12 years; 58 per cent of those 10 and 11 years; 60 per cent of those 9 years; 84 per cent of those 8 years; 95 per cent of those 7 years; 96 per cent of those 6 years; 99 per cent of those laid later, still in service.

In 1880-1-2 there were 150,000 ties creosoted with about 10 lbs. of oil per cu. ft. and put in the tracks of the Houston & Texas Central Railway. Recently it has been found that 11,282 of these are still in service. No information is obtainable as to when the others were removed. Mr. O. Chanute has made some interesting calculations regarding these ties, assuming that those remaining have been in now 24 years and that they will all come out in 2 years more. By applying what he considers the characteristic curve for renewals, based largely upon European experience, extended to take in the per cent of these ties still in track, and therefrom figuring the average life of all the ties, he concludes it probable they have given an average life of 19.35 years.

We have been favored with a report made by representatives of the railroad on the ties in the experimental track on the Gulf, Colorado & Santa Fe, bringing the information thereon down to January, 1907. This piece of track has been described in previous reports and the details will not be repeated here. The results are summarized briefly. All ties were laid in May, 1902. Of 24 untreated black oaks, only 2 remain in track, and they both show decay. Of 153 treated with zinc chloride, none have come out, and only 4 show any decay. Of 60 treated with zinc and creosote, in two injections, all are good.

Of 20 untreated willow oak ties, 15 were removed in 1905 and 1 of the remainder now shows decay. Of 40 treated with zinc, only 1 shows decay; 10 treated with zinc creosote, two injections, are all good.

Of 20 Spanish oaks, 4 are out, and 7 of the remainder show bad decay. Of 41 treated with zinc, all are in good condition. The same is true of those treated with the zinc creosote.

Of 20 untreated turkey or yellow butt oaks, 18 were removed October, 1906, 2 are in track in good condition; 49 treated with zinc and with zinc creosote, are all in good condition.

Of 91 untreated red oaks, 82 were removed in 1905, and of the balance in track, all but 2 show decay. Of 126 treated with zinc, only 4 show any decay; 10 treated with zinc creosote are all good.

Of 197 untreated white oaks, 44 show decay. Of 401 treated with zinc, 2 show decay. Of 100 treated with zinc creosote, 1 shows decay.

Of 49 untreated tamaracks, all were removed in February, 1905. Of 149 treated with zinc, and 49 with zinc creosote, none show decay.

Of 100 untreated loblolly pines, all were removed in May, 1904. Of 200 treated with zinc, 2 show decay. Of 100 treated with zinc creosote, 1 shows decay. Of 80 treated with zinc and Beaumont crude oil, 2 were removed for decay. Of 100 immersed in spirittine, 80 were removed in 1904, 18 in 1906 and the 2 remaining show decay. Of 42 soaked in Beaumont crude oil for 48 hours, 40 came out in 1904, and the balance show decay.

Of 93 untreated longleaf pines, 85 were removed in 1904, and of the balance, all but 1 show decay. Of 100 immersed in spirittine, 8 were removed in 1906, and of the balance, 36 show decay. Of 100 immersed for 48 hours in Beaumont crude oil, 71 were removed in 1906, and of the balance, 4 show decay. Of 200 treated with zinc, none were removed nor show decay. Of 100 treated with zinc creosote, and 100 with zinc and Beaumont crude oil, none show decay.

Of 100 untreated shortleaf pines, all but 1 were out by October, 1906, and the 1 shows decay; of 101 untreated hemlocks, all were out by September, 1904; of 100 untreated beech, none remain; the shortleaf, hemlock and beech ties treated with zinc or zinc creosote, all remain in, and only 4 pines and 2 beeches show decay.

The A., T. & S. F. Ry. has been experimenting along various lines, especially with California crude oil heated and forced into the wood under pressure. Fourteen such ties were placed in the experimental track in February, 1902. These are all still in good condition. Ties boiled in zinc chloride are in equally good condition. There were 84 ties treated at Somerville, Texas, in 1905, with avenarius carbolineum, in the manner specified by the manufacturers, viz., by immersing some ties in the compound heated to between 125 degrees F. and 150 degrees F., and by coating or painting others with the stuff by means of a stiff brush, applying all they would absorb in this way. At present two of these ties have fungi on them and 11 others show decay.

Referring further to the ties treated with the California oil, additional information is given in a letter from Mr. Faulkner, Manager of the Tie and Timber Department of the A., T. & S. F. Ry. System, as follows:

"We have been using crude oil in our engines in California since 1891, and a few years thereafter began sprinkling the roadbed with oil to keep down dust; so that a coating of oil was spread over the tops of the ties, which seemed to add to their life (they were untreated) by keeping the moisture off the tops, at all events this was the belief of the track men.

"In the vicinity of Bakersfield, in Kern County, California, we get an oil, costing about 25 cents per barrel of 42 gallons, of low gravity, which has an asphaltum residuum of about 77½ per cent the balance being mainly light oils, so that when

Dr. Von Schrenk, of the Government Service, asked our people for a length of track in Southeastern Texas to conduct a number of experimental tests on the different wood preservative processes then in common use, we took the opportunity of putting in a few ties of each kind of wood treated with nothing but this same crude oil, alongside the others, in order to obtain a practical comparison of the result. These were treated in the fall of 1901 and put in the track in March, 1902. Where they are laid an untreated loblolly pine tie lasts about two years, and a longleaf pine less than four years on account of heat and moisture, so that we use this piece of track for our wood preservative experiments with the surety that if a tie will last from decay down there a certain length of time, it is good for at least three times the life in other places on the System, judging by the life there of similar wood untreated.

"The timber experts claim that in order to produce decay, moisture and heat must be present at the same time, with access to the air. We therefore took thoroughly well air-seasoned ties, in which, of course, the cells would be more or less open, and filled them with this crude oil heated to 180 degrees F., forced in under a pressure of 150 lbs. to the square inch; at this temperature I am inclined to believe that a good proportion of the light oils had evaporated, leaving only the asphaltum residuum, which was then as fluid as creosote. The ties took up from four gallons up to eight gallons per tie, only one taking the latter amount, and the oil appears to have hardened in the cells under atmospheric temperature, so that up to the present (five years' service) they are in first class shape so far as preservation and wear are concerned. In November last we took one out of the track and sawed it in two in the middle and under each rail base; the wood was as sound and firm as when laid in the track, with less rail cutting than with the other treatments, the spike holding firmly, and when drawn was as bright and clean as a newly made one. We have since taken out another pine tie of a different variety, but sawed, and found on sawing it the same as before, that the wood was just as sound and firm. In one place the sawing developed a decayed place in the tie, which had taken up more oil on account of its decay. This had not spread or caused any trouble, presumably on account of the ring of oiled wood surrounding it.

"In this experimental track we have a number of different kinds of wood treated with different processes. They all show up well excepting one (the Hassellman), which has practically gone to pieces; and as a contrast, in each case we also have a number of the untreated woods inserted for comparison. We do not claim there are any antiseptic properties in the crude oil, but we do believe that by stopping up the open wood cells with a substance which solidifies under ordinary temperature, we prevent heat, moisture and air from getting into the wood and thereby affording an opportunity for the decay-producing organisms to begin work. This seems to be proven in our case, and as a result of the test, borne out by general experience on the divisions where oiling has been done, in the new treating plant we are preparing to erect in New Mexico, the pine ties will be treated with this same grade of crude oil forced in under from 150 to 200 lbs. pressure at a temperature of 180 degrees F. We will probably introduce the oil under a vacuum, and at the end apply a low vacuum before drawing the ties out of the cylinder, in order that the drip may have a show. In this way the ties are reasonably clean and easily handled after treatment. I am also arranging to put in a lot more in the Texas experimental track, and sending some to the Tampico Branch of the Mexican Central."

The analysis of the crude oil used is as follows:

Flashes	242° F.
Burns	300° F.
Specific gravity	0.966
Degrees Beaume	15
Gasoline	Trace
Illum. kerosene	22%
Sulphur	2.41%
Residuum (chiefly asphaltum)	78%

"I give herewith a list of the untreated woods which were laid in the track alongside of these oil treated ties in the early spring of 1902, the oil ties being all in first-class condition at last inspection (four years and ten months after they were laid), while the untreated ones laid at the same time and all inspected together show up as follows:

196 White Oak Ties.
41 show decay, 3 others have fungus on, balance in good condition.

24 Black Oak Ties.
22 removed 4 years after laying, rotten; 2 still in track, but both show decay.

20 Willow Oak Ties.
15 removed 3 years after laying, rotten; of the 5 still in track 1 shows decay, 4 are in good condition.

20 Spanish Oak Ties.
4 removed 3 years after laying, rotten; of the 16 in track 7 show decay with heavy fungus growth on, the rest in fair condition.

20 Yellow Butt Oak Ties.
18 removed 4½ years after laying, rotten; 2 in track in good condition.

91 Red Oak Ties.
82 removed 3 years after laying, rotten; of the 9 still in track 7 show decay, 2 in good condition.

49 Tamarack Track Ties.
All removed 2 years and 9 months after laying, rotten.

100 Loblolly Pine Ties.
All removed 2 years after laying, rotten.

93 Longleaf Pine Ties.
85 removed 2¾ years after laying, rotten; 8 still in track, of which 7 show decay, and 1 in good condition.

100 Shortleaf Pine Ties.
95 taken up 4½ years after laying, rotten; the 1 in track shows decay.

101 Hemlock Ties.
All removed 2½ years after laying, rotten.

100 Beech Ties.
All removed rotten.

The crude oil treatment by the Santa Fe Railway will be confined to those ties treated at the new plant about to be erected at Belen, N. M.; bridge timber, piling and also ties treated at the other plants being creosoted as before.

This experimental track is located purposely in one of the most unfavorable places in this country to the life of a tie. The rainfall is heavy and the heat great. One of the criticisms made in the past years on the results secured with treated ties on the Southern Pacific and the Santa Fe roads, was that such results were not conclusive as to what could be expected in Illinois, Ohio or New York, because these roads ran through arid districts, where everything was favorable to the zinc treated tie. Such criticisms were justified then, but in the light of such evidence as this experimental track affords, of the increased life of the treated tie as compared with the untreated one, there can be no question of the value of such treatment. It does not yet appear what the life of the zinc treated tie will be, but if all of the red oaks so treated come out in 1907, the two years longer life secured therefrom, as compared with the untreated tie, would pay for the cost of treatment; and there is no reason to expect them to come out for years to come.

This is even more true of the pines, beeches and hemlocks. There can be little question but that for such conditions the treatment of the white oaks would be profitable, especially with creosote.

When such experimental results are supplemented by those in the large use in other roads, it would seem that the question confronting the railroad officials would be not, "does treatment pay," but "what treatment will pay best, for this particular road."

The report concludes with a reprint of specifications for Tie Treatment published in Railway Engineering and Maintenance of Way, April, 1906, page 59.

SOME NOTES ON TIE PRESERVATION.

By W. W. Curtis, Vice-chairman Committee on Ties.

Some interesting data concerning treated ties has recently come into the hands of the writer, which is deemed of sufficient value to publish, not that it contains anything new or startling, but progress in tie preservation seems to be a case of "line upon line, precept upon precept."

The tie committee has recommended the methods of handling ties before and after reaching the track, proposed in the accompanying paper. The report in question demonstrates the necessity for such methods in service; it shows certain alleged difficulties with treated ties, being the result of an examination of the ties in the track; and the resulting recommendations, which are to be commended to all users of ties—treated and untreated.

The Chicago & Eastern Illinois Railroad has been using ties treated by the zinc-tannin process since 1899. Up to January 1, 1906, one and one-quarter million of such ties have been used. Up to the same date, during the seven years, 6,087 treated ties have been removed from track. In Bulletin No. 78 the details of these figures have been given, which are self-explanatory. If anyone can match this record with untreated white oak ties, it would be of interest to know it. If the ties reported as removed on account of "changing track" and "tracks taken up" be omitted, leaving in those reported as burnt and destroyed by wrecks, there have been only 1,489 ties removed for cause out of all those laid in track during the seven years.

Attention is called to the fact that this railroad does not run through a desert. The southern end reaches the Ohio River, where it rains to the amount of about 43 inches each year; perhaps a fair average for the entire line would be 37 inches.

These ties were treated at Mt. Vernon, Ill., and the record of the amount of solution injected and its strength may be of interest. The heading "gallons of sap extracted" is hardly accurate. This is partly condensed steam.

We are indebted to Mr. A. O. Cunningham, chief engineer of the Wabash railroad, for permission to reprint the report of the inspection of ties; and to Mr. W. S. Dawley, formerly chief engineer of the Chicago & Eastern Illinois, for the report on ties removed.

REPORT OF INSPECTION OF TRACK, CONSISTING OF TREATED RED OAK, WABASH R. R. CO. INSPECTION MADE APRIL 10, 1905, NEAR CUSTER PARK, ILL.

Reports received from time to time of excessive checking of red oak ties treated with zinc-chloride, after they had been placed in track, it was thought advisable to make a careful examination of some of these reported checked ties to determine whether the checking was due to the treatment, and in how far the spiking was responsible for the splitting of ties. The reports which had been made dwelt chiefly upon the fact that treated red oak ties split very badly when a spike was driven into them, and, furthermore, that the holding power of the treated red oak was not as great as for untreated timber.

In determining problems of this character it is well to keep in mind the physical qualities of the wood under consideration. The red oak is a porous wood, which is generally full of water, and which, when exposed to seasoning influences, has a tendency to dry with great rapidity in a more or less uneven manner, resulting in checks and splits. The red oak has this in common with many other inferior woods like beech, gum, etc. In view of the fact that timbers like the red oak, gum, etc., will have to be used to a very large extent for the future supply of railway ties, it seems very desirable to become cognizant with the nature of this wood, and should it prove that it checks excessively before or after treatment, means will have to be devised for reducing this checking, for there can be no doubt but that these timbers will have to be used in some form or other. Any inspection into condition of service which timber of this character gives should be made from a constructive standpoint, as distinguished from a destructive standpoint. In other words, the object should be to determine how to overcome any possible defect, rather than to throw out the material because of such defect. With this in mind, the following observations were made:

CHECKING.

A large number of checked red oak ties were found in the track. These checks were all the way from small checks to such as extended from the end into the tie near the rail. The checks were largely end checks, which were obviously due to the nature of the wood, and in the majority of cases were in such position that the spike could not be held responsible for the formation of the checks. There was frequent evidence that spikes are even driven into incipient checks, the tendency, for the section men being to put a spike into the check so it would stand up, and then drive it, thereby increasing the split. Examination, however, made it evident that some of the worst checks had no relation to the spike position.

In many of the ties where the checks extended out from the spikes, these were driven while the timbers were in frozen condition, and this would easily account for the excessive checking in those cases.

The general conclusion to be drawn from the inspection was that the checks in the red oak treated with zinc-chloride bore no relation to the driving of spikes, but were due to the peculiar nature of the red oak.

PREVENTION OF NATURAL CHECKING.

The natural checking of timber like the red oak is a serious matter. It is due, first of all, to the drying of green timber before treatment, and, second, to the drying out of timbers after being treated with a water soluble salt.

It is suggested (a) that the checking be prevented by the adoption of close piling both before and after treatment, which would very materially reduce the checking tendency. This is especially true of the piling of treated ties. Treated ties should under no circumstances be laid in the track while still full of water. They should be stacked until dry, along the right-of-way, in the form of a close pile, so that the timber may season slowly. They should be piled at least four months.

(b) Position of the tie in the track. Care should be taken when laying timbers in the track that all ties placed should be laid heart side down. This will not only reduce the checking tendency, but also increase the length of service by reducing the leaching tendency of the salt.

(c) It is recognized that in spite of all care and attention to seasoning of red oak and similar timbers, before and after treatment, that these timbers will check. Woods of this character have been in use on European railways for many years, and the chief device used for preventing this checking tendency is the S iron. These S irons are made of malleable iron of various sizes, and are driven into the ends of ties across incipient checks. These irons are usually placed in the ties before treatment. As many of the ties are purchased in a treated condition, this may not always be practical, and such irons should then be placed after treatment, or immediately after the ties are received by the railroad company. I regard the use of these S irons as a cheap and at the same time an extremely serviceable device, which will pay many times over in the way of increasing length of service of such woods as the red oak. My recommendation would therefore be to the end that some of these irons be made at once and applied wherever ties are starting

to check. An early prevention of a ½-in. check will make possible the use of a tie, which, without such prevention, would continue to check beyond hope of saving it.

(d) All badly split ties should be rigidly rejected to start with, and under no condition should such checked ties be laid in the track.

WEAR AND RAIL CUT.

It was noted that many of the treated red oak ties had cut badly towards the outside of the track in many instances. Many of the spikes were bent at angles of 30 degrees outward, and the wood on the outside was correspondingly broken and twisted; all this with ties which had not been in track for quite a year. This serious condition of affairs I regard as due to factors for which the red oak timber cannot be considered responsible. The traffic which is going over this track is evidently extremely heavy, and the lateral working of the track as a whole is uneven, due to improper ballasting. Under such circumstances, it is not strange that the ties are cut and the spikes bent. With a thoroughly ballasted track, such a condition would certainly never arise. The main point in this connection, however, is that the conditions should not be regarded as average conditions, and the red oak must not be held responsible for the excessive rail cut and wear.

DECAYED TIES.

A considerable number of badly decayed ties were noted. The decay was of a kind which was in the tie before treatment. These ties should never have been laid, but should have been promptly rejected. It makes no difference whether these decayed ties were received free of cost from the contractors. The laying of such ties, which serve only a very short period, gives false impressions as to the value of treatment, because when renewal records are made, it is difficult to distinguish whether a tie has decayed in service or was already decayed before being placed. A decayed tie is of no value from the time it is laid in the track, and the labor expended in placing it makes it a very poor investment. A stricter inspection is recommended at the time treated ties are received.

OLD SPIKE HOLES.

It was noted that a good many of the ties in the track had been replaced, leaving the old spike holes. In the case of timbers treated with a water solution salt, great care should be taken to plug all old spike holes. These form one of the most fruitful sources for the leaching out of the zinc-chloride and for starting premature decay.

POSITION OF TIE IN TRACK.

Reference has already been made both to the fact that in many cases ties are laid with the heart side up, which results in heart and ring check. Wherever split ties are used, care should be taken to lay them heart side down.

DATING NAILS.

It was noted that a great many dating nails were not driven completely down. Instructions should be given that all dating nails should be driven so that the head is flush with the top of the tie, as only by so doing can these nails be expected to last. A more important feature, however, is the time of driving the nail. It was noted that many treated red oak ties had nails in them, which indicated that they were untreated white oak. Mistakes of this kind can only arise when the nails are driven into the ties after the same have been laid for various lengths of time. In view of the fact that the use of the dating nails is one of the most important factors in connection with accurate records, too much stress cannot be laid upon the instructions that all nails should be given the same day that the tie is laid, and under no circumstances afterwards. All section men should have a sufficient supply on their handcars to be ready for any emergency.

The general conclusion to be drawn from the examination made is that there was no evidence of excessive checking in red oak due to treatment; that the checks which had formed can largely be prevented by close piling of treated ties for at least four months along the right-of-way, by careful laying of ties with the heart side down, and by the use of S irons.

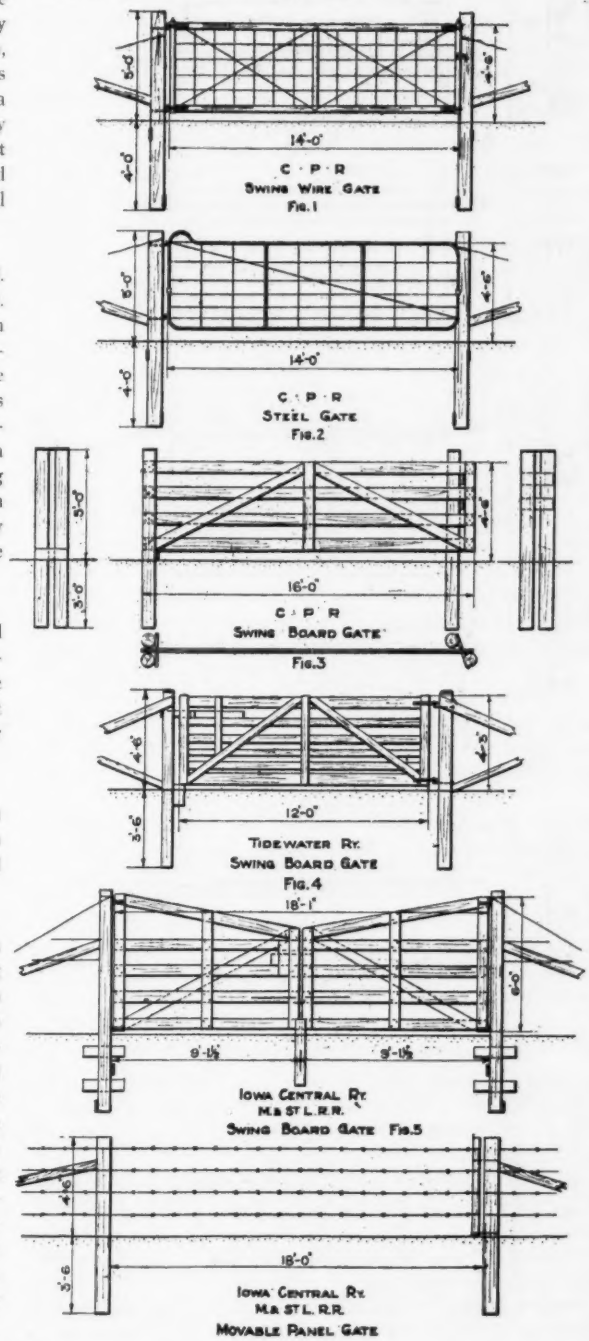
In conclusion of these notes the causes underlying the limited production of creosote in the United States is taken up from an article described in the October, 1906, issue of Forestry and Irrigation.

Signs, Fences and Cattle Guards

The report is made up largely from the opinions expressed by different members in reply to a circular of inquiry.

GATES FOR RIGHT-OF-WAY FENCES.

Four types of gates are largely used on our railways, illustrations of which are hereto appended:



(1) Hinged wood frame wire gate.
(2) Hinged tubular steel wire gate.

(3) Swing board gate.

(4) Hinged board gate.

The height in all cases is 4 ft. 6 in. above the ground.

The length of single gates varies from 12 ft. to 16 ft.; 16 ft. is considered the maximum length for single gates.

The length of gates required on different railways depends upon local requirements. In wheat country, where modern harvesting machinery is used, the length of gate required to pass

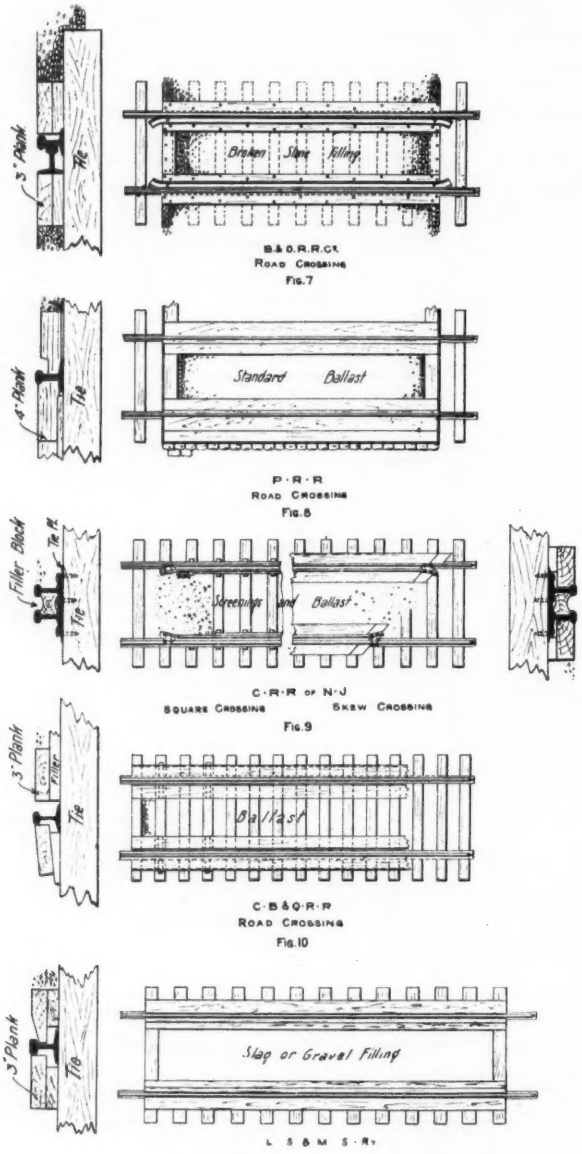


FIG. 11

the largest machines fully set up is 20 ft. To provide a 20-ft opening requires a double gate. This style of gate is shown in Fig. 5. The double gate can, of course, be made of either of the first four types.

In cases where gates are infrequently used the movable panel arrangement for opening the fence, shown in Fig. 6, is most economical.

Several railways manufacture gates out of old locomotive boiler tubes and fence wire.

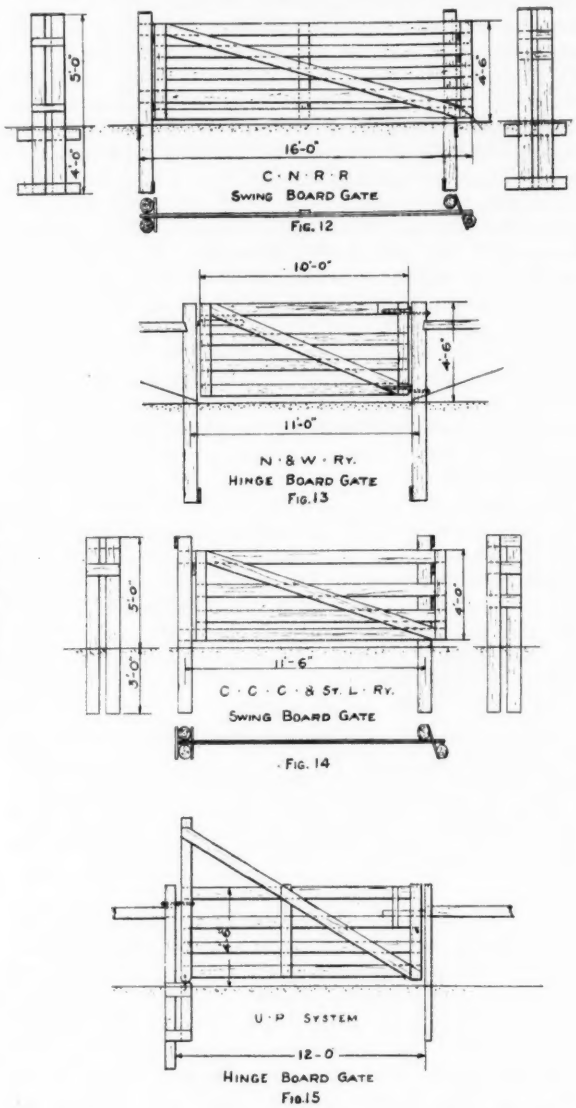
The committee recommends the swing board gate where traffic is very light, the hinged board or hinged tubular wire gate at other points, whichever is the cheaper.

RIGHT-OF-WAY FENCE POSTS.

Posts are usually made of clear, chestnut, locust, oak, catalpa, and some Bois-d'Arc; the average life is as follows:

Chestnut and oak	9 years
Locust	10 years
Catalpa	12 years
Cedar	15 years
Bois d'Arc	everlasting

Some experiments are being made with reinforced concrete



posts, but as yet the railways experimenting are not prepared to make any definite recommendations.

HIGHWAY AND PRIVATE ROAD GRADE CROSSINGS.

Street crossings are generally constructed of four-inch plank laid solid.

Highway and private road crossings are usually constructed of four planks, one on each side of each rail, and the space between filled with ballast, broken stone filling or screenings and ballast, as per Figs. 7, 8, 9, 10 and 11.

Flangeways are provided (1) by rabbiting or beveling the plank; Fig. 8 and 11.

(2) By an additional rail laid workwise, same as a guard rail, with filler block between; Fig. 9.

(3) By laying rail on its side; Fig. 7.

The third method is used by practically all railways on busy crossings with good results.

SIGNALS AND GATES AT HIGHWAY CROSSINGS.

For crossing with limited amount of highway travel the automatic crossing alarm bell has been generally adopted, where some form of protection is demanded, with good results.

Where highway travel is great, railway crossing gates are generally used. The type of crossing gates in general favor is the pneumatic gate. The special advantage of the pneumatic gate over the chain and wire-connected gate is the reduced cost of maintenance.

METAL AND WOODEN TRACK SIGNS.

The use of purely metallic signs, set in concrete, is limited to a few roads, who believe in their ultimate economy.

There is a more general use of metallic signs on wooden posts.

The great majority of roads, however, use all wood posts and signs.

In designing metallic signs, smaller dimensions are used than those of wood, and still their cost is from double to treble that of wood. On account of their small size and excessive cost the committee is not ready to recommend them for general use.

CONCLUSIONS.

The committee recommends the swing board gate where traffic is very light, the hinged board or hinged tubular wire gate at other points, whichever is cheaper.

Classification of Track

The special committee on "Classification of Track" recommended the following at the 1906 convention for adoption and was decided at that meeting it be submitted to letter ballot. The result of ballot was 152 in favor and 8 against.

Class A shall include all districts of a railway having more than one main track, or those districts of a railway having a single main track with a traffic that equals or exceeds the following:

Freight car mileage passing over district per year per mile, 150,000; or, passenger car mileage per year per mile of district, 10,000; with maximum speed of passenger trains of 50 miles per hour.

Class B shall include all districts of a railway having a single main track with a traffic that is less than the minimum prescribed for class A, and that equals or exceeds the following:

Freight car mileage passing over district per year per mile, 50,000; or, passenger car mileage per year per mile of district, 5,000; with maximum speed of passenger trains of 40 miles per hour.

Class C shall include all districts of a railway not meeting the traffic requirements of classes A or B.

Track

The committee recommends in general switch points 10 ft. long for No. 4, 5, and 6 turnouts and switch points 16½ ft. long for No. 7, 8, 9, 10, 11 and 12 turnouts. For turnouts greater than No. 12, special points to suit the conditions are recommended.

Split switches and bolted spring rail frogs are recommended as best for main track use.

SWITCHSTANDS: For class A railroads, where speed exceeds 30 miles per hour, main track turnouts should be equipped with semaphore type of switchstands with distant signal, reinforced switch points, facing point lock, reinforced spring rail frog, and upon such sidings where cars are allowed to stand and upon passing sidings with a derail to operate any connection with main track switchstand.

The type of switchstand for facing point switches is recommended as shown in Fig. 1. This stand is intended to correspond with the practice of interlocking signals; upper arm governing main track routes and lower arm governing sidetrack routes, and is for switches where interlock has not been established. At points where the speed of trains is greater than 45 miles per hour, the committee thinks it impracticable to operate wire-connected or pipe-distant signals, and would prefer at such points distant signals of the electric type.

Main track switchstands should have the following parallel throw: There should be two levers, one to operate the facing point lock and the second to operate the switch. These two levers to be so arranged that it will be impossible to get clear signal for the main track unless the switch is locked for the main track.

For yards and inner switches, switchstands having adjacent parallel throw with a double banner is recommended.

SWITCH POINTS: Switch points should be made of open-hearth steel; details, reinforced bars, switch plates, elevation of switch point above stock rail, lugs, bolts, tie bars and facing point lock rod as shown on drawing. Facing point lock rod may be varied to conform to interlocking standards recommended by the committee on "Signaling and Interlocking."

FROGS: The bolted type of frog is recommended. The lengths of all frogs No. 8 to and including No. 10 should be 15 ft. Frogs of other numbers should have a length to suit conditions. Your committee recommends in general frogs to be made of open-hearth steel conforming to standard specifications for that article, and believes that frogs for yard service made of manganese steel to be the most economical.

The committee submits a drawing for No. 10 spring rail frog for main track service. The three center plates are extended so as to conform to gage plates, in order to secure accurate gage for guard rails at the point of frog. A 2-in. flangeway is recommended. Fillers should be made of rolling steel, fit snug in rail, solid and continuous. Bolts to be made of fine BB iron, round and true to size, U. S. standard heads and threads, threads should be accurately cut and ends have wrench-tight fit. All bolts should have cotter pins just outside of nut, size of bolts as shown on drawing. Bolt holes to be drilled; drilling to be accurately done and holes be made $\frac{1}{16}$-in. less in diameter than bolts to be used; parts should be assembled and holes reamed, in order to be straight through and of such size as to give bolt driving fit; foot guards as shown on drawing. The bottom plates should be made of rolled steel.

GUARD RAILS: Guard rails 11 ft. long, with beveled end bolted to main track rail with fuller blocks and foot guards are recommended, with flangeway of 2 in. between main track rail and guard rail. Drawing guard rail is shown on plan of frog.

Glazed sewer pipe with bell end is recommended for drainage in wet cuts. The pipe should be laid without cemented joints, be covered with hay or straw and cinders, and laid below the frost line.

The committee believes that slides are best cured by the use of French or pillared drains. This subject is fully treated in a paper entitled, "The Clay Slide at Boone Viaduct," by Mr. A. W. Merrick, published in the "Journal of the Western Society of Engineers," June, 1906.

After careful consideration, your committee can find no reasons for changing the recommendation for drilling of rails.

Your committee appointed a sub-committee to confer with the American Railway Master Mechanics' association on the subject of widening the gage on curves as affected by the different lengths of engine wheel base and arrangement of flanged wheels. A meeting was held at the office of the association, two members of the American Mechanics' association and two members of the track committee being present. The matter assigned the committee was taken up and discussed in detail and the plans for a future meeting of the committee were perfected.

Two meetings of the ballast committee relative to ballast cross sections have been held. The recommendation of the ballast cross section will show the opinion of the majority of those present at the meeting.

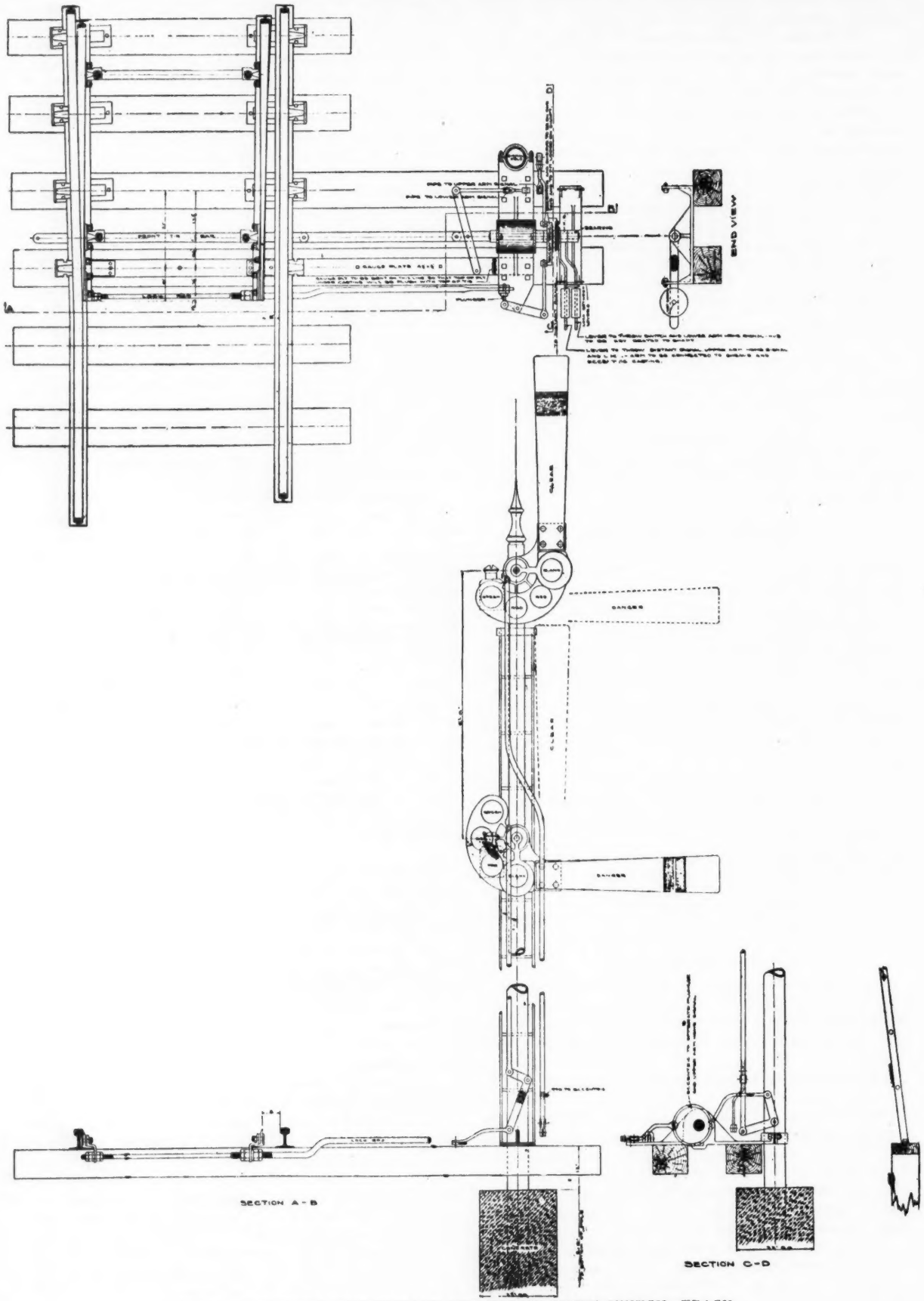


FIG. 1.—PROPOSED SWITCHSTAND FOR FACING POINT SWITCH—TRACK

A STUDY OF THE STRESSES EXISTING IN TRACK SUPERSTRUCTURE AND RATIONAL DESIGN BASED THEREON.

By O. E. Selby, Bridge Engineer, Cleveland, Cincinnati, Chicago & St. Louis Railway.

When a bridge superstructure breaks down, we at once make a careful examination not only of the broken parts to determine if defects existed in them, but also of the loads applied and the unit stresses resulting therefrom. We criticise the arrangement of connections and proportions of parts. When a rail breaks under traffic, we conclude that it was piped, and draw morals based on the superior quality of Edgar Thomson sixty-pound rails which last thirty years or so under traffic.

When a bridge pier cracks or begins to churn up and down under passing loads we investigate the live and dead load reactions on it and the depth and character of foundations; then we

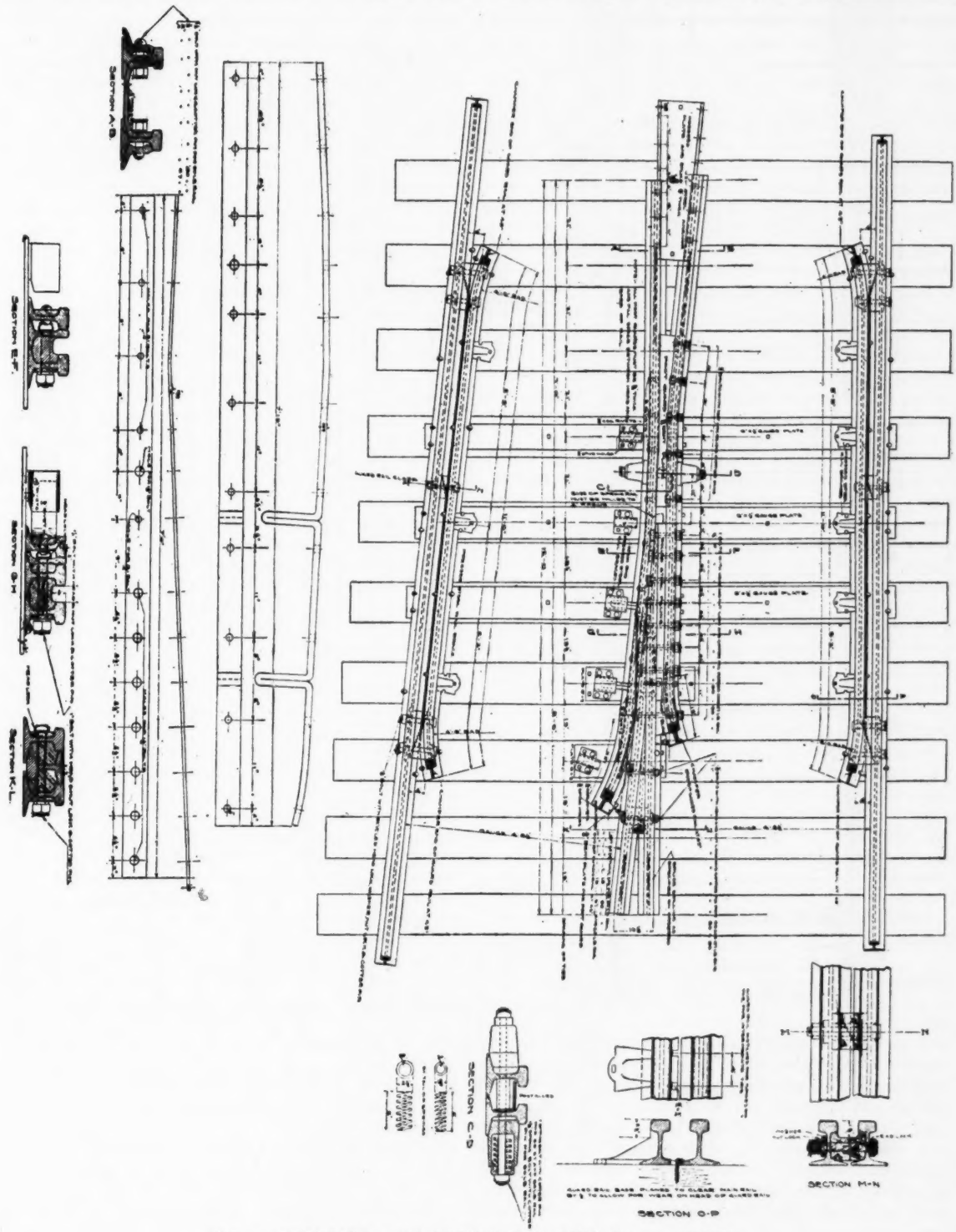


FIG 2.—PROPOSED 15-FT. SPRING RAIL FROG NO. 10—TRACK.

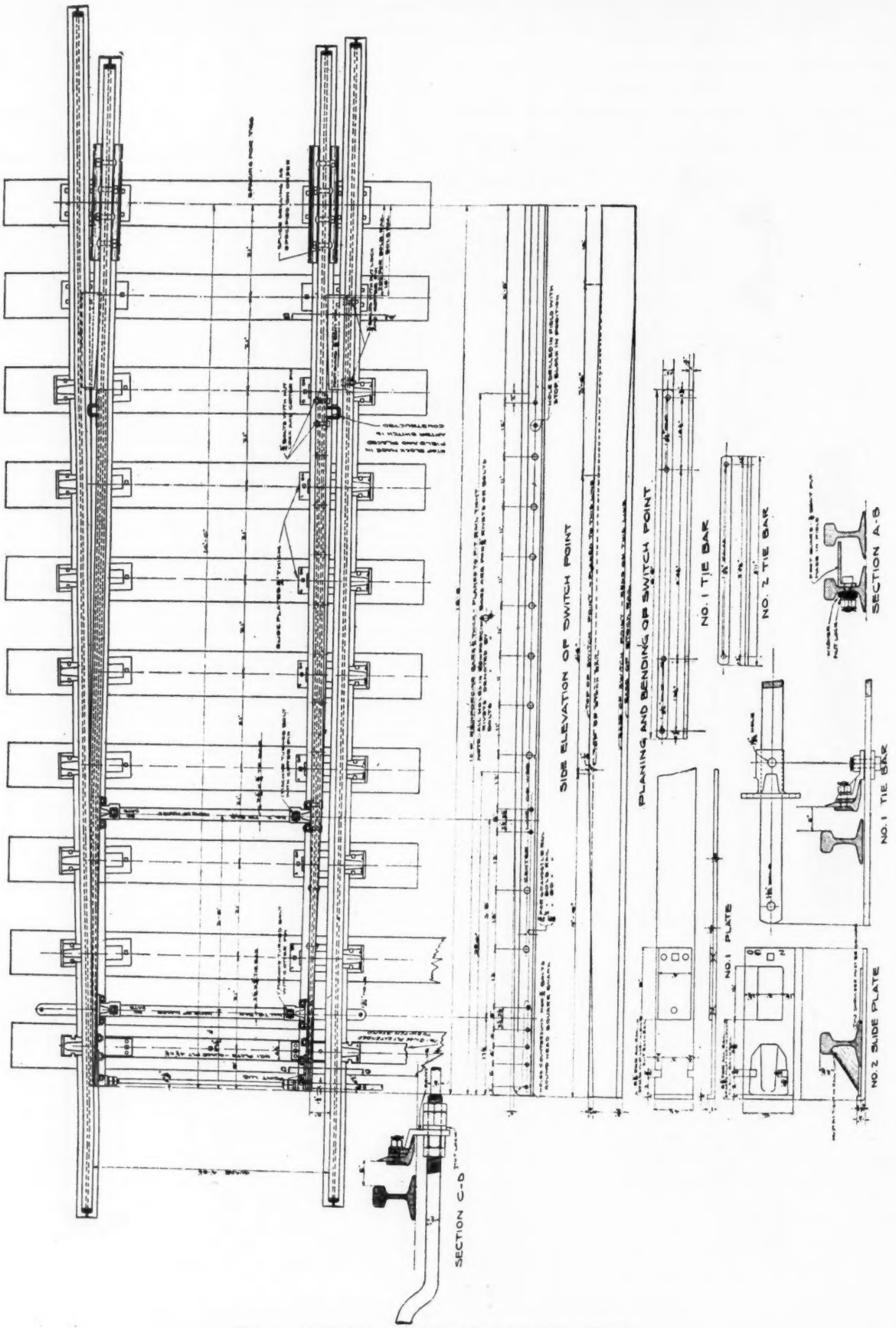


FIG. 3.—PROPOSED 16½-FT. SPLIT SWITCH—TRACK.

reinforce it or rebuild it in such a way that it may be made a permanent structure. When a cross-tie begins to churn up and down in the ballast, do we report that the ballast is overloaded and that a wider or better foundation for the tie will have to be secured? We do not. We simply pack the ballast back under the tie and hope, if it is well packed, it may not get loose again soon.

When a retaining wall leans forward, or a heavily loaded corner of a building settles, we ascertain if the width of the wall at the base is in proper proportion to the height and if the load on the clay under the building is uniformly distributed. When a railroad track settles out of level and its clay foundation is forced up between the ties we patiently dig out the clay, get more ballast, if the shovel has not been shut down, and waste our mental energies accumulating statistics on the creeping of rails in the direction of heaviest traffic.

Railroad track has grown in strength as heavier loads have made increased strength necessary, but such growth has been entirely along empirical lines and not one single detail of track superstructure bears marks of engineering design.

The track, which at the beginning of railroads was a detail, has risen to the position of a complex structure carrying the same heavy and destructive loads as the bridges and deserving of the same careful design. Therefore, it seems proper to examine the unit stresses existing under present conditions and, if possible, apply proper unit stresses to designs for a permanent, or, at least, more durable, structure.

The essential parts of a track, aside from the fastenings, are the rails, ties, ballast and subgrade. These may be likened to the analogous parts of a bridge structure, viz: girders, piers, footings and foundations. In the track the spans are short, the girders continuous and subject to reversals of stress, and, moreover, are universally made of Bessemer steel. The piers are close together, shallow and subject to decay. The footing courses are gravel or broken stone without binding material, and the foundation is on wet clay, usually made ground and always above the frost line; so that from a bridge designer's point of view the track is a very unsatisfactory structure.

We may assume as a typical first-class track: 80-lb. rail, with 7x8 in. by 8½-ft. ties, twenty to a 33-ft. rail, on 12 in. of gravel ballast carrying locomotives with 50,000-lb. axle loads spaced 5 ft. center to center. Examining first the bending stress in the rail we have 50,000-lb. axle loads on supports 20 in. apart. For these conditions the American Railway Engineering and Maintenance of Way Association specifications for steel bridges, paragraph 5, call for 100 per cent. impact, making the stresses equivalent to those from a 100,000-lb. axle load or a 50,000-lb. wheel load. For a simple beam the bending moment in one rail would be 250,000-in lbs. For a continuous beam with rigid supports it would be two-thirds that and for a continuous beam with partially yielding supports three-fourths of the bending moment for a simple beam is reasonable, giving 187,500-in. lbs. If we consider the wheel placed over a tie which yields enough to carry one-fourth of the load to each adjacent tie, the resulting moment in the rail is the same. The section modulus of an 80-lb. A. S. C. E. rail is 10.0, making the extreme fiber stress 18,750 lbs. per sq. in. For a 90-lb. rail the unit stress is reduced to 15,600, and for a 100-lb. rail to 12,800.

Passing to the load on the tie we encounter an element which must vary between rather wide limits with the stiffness of the rail and yielding of the supports. With a simple beam and load placed midway between supports, the reaction on each support would be one-half the load. The theory of the continuous girder would make the reactions about 55 per cent to 67 per cent, depending on whether the load is placed over a support or midway between. The yielding of supports would undoubtedly reduce these percentages. Bridge specifications usually consider the load equally distributed among three ties, but bridge ties are spaced usually 14 in. between centers, so that, if the load going to one tie is proportional to the tie spacing, the amount for 20 in. spacing would be 20-14x1-3=20-42=47.6 per cent. Therefore, the assumption that the maximum load on a tie is half the axle load seems a proper one. With a 25,000 lb. load on each rail bearing, the bearing per sq. in. on tie is 625 lbs.

In investigating further stresses in the tie and bearing on ballast some uncertainty as to the distribution of the load effected by the tie is encountered. If a uniform distribution is attained the load per linear inch on a tie with an effective length of 100 in. is 500 lbs., and the greatest bending moment is (at the center) 125,000-in. lbs. If we consider that the center is not well tamped and that the bearing is uniform over a length equal to twice the over-hang or 20 inches each way from the rail, the resulting maximum moment (under the rail) is the same as before. With a tie 7 in. deep and with 8 in. face the extreme fiber stress is 1,920 lbs. per sq. in. If by reason of irregularities of tamping, etc., the bearings become concentrated at the ends or center instead of distributed, the above unit stress may be doubled and result in broken ties.

For bearing on ballast, if we take the first and most favorable assumption, we have 50,000 lbs. on 800 sq. in. or 4.5 tons per sq. ft. If the bearing is only 20 inches each way from the rail it amounts to 5.6 tons per sq. ft., or an average of, say, 5 tons.

For computing the bearing on subgrade we are furnished a method by Mr. Thos. H. Johnson's study contained in proceedings of the American Railway Engineering and Maintenance of Way Association. The formulas given therein are deduced from two premises: first, that the width of distribution of the load effected by the ballast is equal to the width of the tie plus the depth of ballast for stone ballast or plus half the depth for gravel ballast; second, that the intensities of pressure within that width are proportional to ordinates to a circular curve whose radius and chord are each equal to the width of distribution. The width of distribution for a tie with 8 in. face and 12 in. gravel ballast is 8 in.+6 in.=14 in. The same ratio of spread obtains at the ends of the tie, so that the bearing area on subgrade is 14 in.×106 in.=1,484 sq. in., and with a 50,000-lb. load the average pressure is 2.4 tons per sq. ft. The maximum pressure is about 1½ times this or 3.6 tons per sq. ft.

All of the foregoing unit stresses except the bending in the tie under favorable conditions and the bending in 90-lb. and 100-lb. rails are far in excess of what would be considered safe or good practice in a bridge structure, and it is not to be wondered at that we have broken rails, cut rail seats, broken ties, loose and pulverized ballast and clay ridges between the ties. There is no more justification for continuing a small than a large structure in service with higher than allowable unit stress on open-hearth steel in connection with 100 per cent disastrous wreck; consequently greater risk may be taken. This is the case with all the elements of the track except rail, hence we repair the failures as they occur and suffer a heavy maintenance expense in order to save the first cost of a better structure.

Passing now to the design of a track superstructure which will overcome the defects of the present track we must fix on the loads and unit stresses to be adopted. For these we turn again to bridge practice. Modern specifications call for an E-60 loading, which contains 60,000 lb. axle loads spaced 5 ft. between centers. The American Railway Engineering and Maintenance of Way Association specifications allow 16,000 lbs. extreme fiber stress on open-hearth steel in connection with 100 per cent. impact for spans as short as those we are dealing with. For Bessemer steel only 15,000 lbs. should be allowed. The same specifications allow 2,000 pounds extreme fiber stress on timber. For bearing on timber (white oak) the United States bureau of forestry recommends 400 pounds per square inch. For bearing on gravel or broken stone not well confined, 4 tons

per sq. ft. is as much as should be allowed. For bearing on clay foundation, subject to frost and usually made ground, 1 to 1½ tons per sq ft. is good practice.

RAIL.

Consideration of bearing on ballast and subgrade demand that the rail be stiff enough to secure uniform distribution of loads lengthwise of the roadbed. A tie spacing equal to one-half the wheel spacing would load the girder (rail) at the quarter points and produce moments (in a simple beam) equal to those produced by a uniform load. A more practicable tie spacing one-third of the wheel spacing would similarly produce moments 1-72 part, or only 1.4 per cent greater than those from a uniform load, so that if we design a rail for uniform load equal to the wheel load divided by the wheel spacing, the result will be very nearly correct. The wheel load with impact is 60,000 pounds, or 1,000 pounds per linear inch of rail. For a continuous beam (indefinite number of spans and loads) the maximum moment is $WL^2 \div 12 = 300{,}000$ in. lbs. For a fiber stress of 15,000 a section modulus of 20.0 will be required. This is twice the section modulus of an 80-lb. rail, and 37 per cent greater than that of a 100-lb. A. S. C. E. rail.

It would require about a 115-lb. rail if designed on the lines of the A. S. C. E. section, but the same stiffness could be secured with a 100-lb. rail 7 in. or 8 in. deep, similar to the deep T-rail sections designed for street railways. It is important to note that this design takes full advantage of the continuity of the rail, and, hence, would require 100 per cent joints and practically non-yielding supports.

BEARING ON TIE.

Space ties 20 in. center to center (20 to a 33 ft. rail), then the load on one tieplate (with impact) $= 60{,}000 \div 3 = 20{,}000$ lbs., and required area of the tieplate $= 20{,}000 \div 400 = 50$ sq. in. This is secured by a tieplate 6¼ in. by 8 in.

BENDING OF TIE.

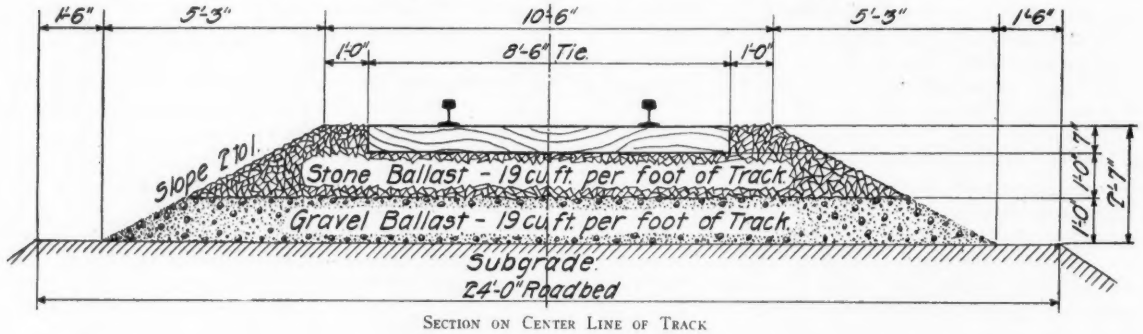
Space ties 20 in. center to center and assume distribution as in previous discussion, then bending moment $= 100{,}000$ in.-lbs. A unit stress of 2,000 lbs. in extreme fiber will require a tie 7 in. deep and 6 in. face. On account of irregularities in ballast and tamping this ought to be increased 50 per cent., making a 9-in. tie. Ties of 9-in. face space 20-in. centers will, with irregularities of spacing and widths of tie, give an average clear space of 10 in., which is as small as is consistent with good tamping.

BEARING OF TIE ON BALLAST.

Use 9 in. ties spaced 20 in. If the load is distributed uniformly by the tie throughout the length, the bearing on the ballast is 3.13 tons per sq. ft. If the load is distributed uniformly for 20 in. each way from the rail, the bearing is 3.8 tons per sq. ft. Neither of these exceeds the allowed unit stress of 4 tons, but irregularities would probably bring the maximum intensity up to that amount.

REQUIRED DEPTH OF BALLAST.

By Johnson's formula, before referred to, the required depth of stone ballast is 4/3 (20 in.—¾×9 in.) = 17.67 in., say 18 in. This is a very large amount of stone ballast, and economy will usually result if gravel is substituted for part of it. By the Johnson formulas, gravel has just half the distributing value of stone, and its cost under the track may be considered practically half that of stone, so that, if we use 12 in. of stone ballast and make up the other 6 in. with twice the depth of gravel, we have 24 in. of ballast; the lower 12 in. being gravel and the upper 12 in. stone. All depths of ballast used in this paper are depths under the tie. Such a depth of ballast will require a roadbed with a width of 24 ft., for single track, at subgrade, as indicated on the cross-section herewith.



SECTION ON CENTER LINE OF TRACK

7"x9"x8'-6" Ties spaced 20 to a 33'-0" Rail = 20" c. to c.
Rail about 7" high, 6" Base, Section Modulus = 20.0
Stone Ballast
Gravel Ballast
Subgrade
1'-0"
2'-7"

CROSS-SECTION—SINGLE TRACK.

STUDY OF TRACK STRESSES

BEARING ON SUBGRADE.

The width of distribution of a single tie load is, by the Johnson formulas, 9 in. + 12 in. + ½ 12 in. = 27 in., and substantially uniform distribution over the subgrade is secured when the tie spacing is three-fourths of that width or 20¼ in., which agrees with the spacing adopted. The load (with impact) is one ton per linear inch of roadbed, and if distributed over 10 ft. width the average load per sq. ft. on subgrade is 1.2 tons. The maximum is $3/2 \times 20/2.25 \div 10 = 1.33$ tons per sq. ft.

MERITS OF ABOVE DESIGN.

The design of track indicated by this study would, of course, cost much more to build than any existing track, but, if properly built on a settled and permanent subgrade, properly drained and protected from accumulation of mud and cinders, it is reasonable to expect that the cost of maintenance of the track superstructure proper would be reduced more than half. The decreased maintenance cost together with the increased security and smoothness of riding would justify the larger capital expenditure.

The foregoing design takes into account future increase of loads and may be considered somewhat visionary, and the

limitations of present rail sections force us to the study of how to build the best track for existing loads using present rail sections of 80, 90 or 100 lbs. per yard. The figures deduced in the previous study furnish a guide to the methods of strengthening needed to reduce the unit stresses to proper limits.

DESIGN FOR TRACK UNDER 80-LB. RAIL.

The fiber stress in the rail must be reduced from 18,750 to 15,000 by closer spacing of ties. The required spacing will be 16 in. If such close spacing is not practicable, it is clear that 80-lb. rail is too light for existing loads. However, we may tentatively assume it practicable, and investigate the tie and ballast conditions. Having given rail conditions and loads, we must assume that the load on the tie varies inversely with the stiffness (or distributing value) of the rail. That is to say, a heavy rail will, with the same loads, require fewer ties than a lighter rail. This has been found true in practice within limits, and is in conformity with the stresses in the rail. It is also assumed that with a given wheel load and rail section the load on the tie varies directly with the spacing. Now if for 80-lb. rail and 20-in. spacing the tie load is 50,000 lbs. for 16-in. spacing it will be 16/20 of that, or 40,000 lbs. The required bearing on the tie will be $\frac{20{,}000}{400}$=50 sq. in. This would require a tie-plate 6¼ in.×8 in.

The bending in a 7 in.×8 in.×8½ ft. tie will be 1520, which is satisfactory.

The bearing on ballast will similarly be between 3.6 tons and 4.5 tons, or say 4 tons.

The depth of ballast required to secure uniform pressure on subgrade is by the Johnson formulas:

4/3 (16 in.—¾ 8 in.)=13.3 in. for stone, say 14 in.

or 8/3 (16 in.—¾ 8 in.)=26.7 in. for gravel.

DESIGN FOR TRACK UNDER 90-LB. RAIL.

The bending on rail will permit of 20-in. spacing of ties. The tie load, on account of variation with the section moduli of the rails, would be 42,000 lbs., producing a unit bearing on the ballast of 4.2 tons. To reduce this to 4 tons, the spacing must be reduced to 19 in. or say 22 ties to a 33-ft. rail, giving 18-in. spacing. The depth of ballast required for 18-in. spacing is 16 in. for stone, or 32 in. for gravel.

DESIGN FOR TRACK UNDER 100-LB. RAIL.

The rail section will permit of 23.4 in. spacing of ties, or say 18 ties per 33-ft. rail, 22-in. spacing. The tie load for 22-in. spacing under 80-lb. rail would be increased to 55,000 lbs. and for 100-lb. rail would vary with the section modulus and be reduced to 38,000, producing a unit bearing on the ballast of 3.8 tons, which is below the 4 tons allowed.

The depth of stone ballast required with 22-in. spacing would be 21.3 in. To reduce this to a reasonable depth we must adopt a tie spacing of 20 in., or 20 ties to a 33-ft. rail, for which the depth of ballast required will be 18.7, say 18 in.

MERITS OF DESIGNS.

The depths of ballast given in the three foregoing designs are intended to give practically uniform pressure on subgrade, and that (with impact) amounts to 1 ton per sq. ft. The maximum intensity is about 1.2 tons.

Similar studies contemplating the use of ties with 9-in. face reveal no advantage commensurate with the increased cost and difficulty of securing such ties.

It is thus seen that with a given rail section and size of tie the only elements we may vary are the tie spacing and depth and character of ballast, while the particular element which determines these varies with the weight of rail. With 80-lb. rail the tie spacing is fixed by the weakness of the rail, while the depth of ballast follows from the close tie spacing fixed and is correspondingly shallow. With the 90-lb. rail the tie spacing and consequent depth of ballast are determined by the bearing of the tie on the ballast. For the 100-lb. rail the tie spacing is determined by the requirement of a reasonable depth of ballast.

Below is given a recapitulation of the designs:

Rail.	80 Lbs.	90 Lbs.	100 Lbs.	Rail with Sec. Mod. 20 0.
Axle load	50,000 lbs.	50,000 lbs.	50,000 lbs.	60,000 lbs.
Size of tie	7"x8"x8½'	7"x8"x8½'	7"x8"x8½'	7"x9"x8½'
Spacing of ties	16"	18"	20"	20"
Number of ties per 33 ft. rail	24	22	20	20
Depth and kind of ballast	14" stone	16" stone	18" stone	12" stone on 12" gravel
Width of roadbed	21'	21'	22'	24'

Whatever view may be taken of the accuracy of the mathematical deductions herein, the writer believes that they are consistent among themselves and supported by observed methods of failure. He believes that they show the weak spots of the present track superstructure and point the way to the places where improvement should begin.

Water Service

The report commences by discussing the different methods in use for water softening.

For a number of years railway companies have been crudely treating their boiler waters by introducing either a boiler compound or soda ash into the locomotive tanks. As the different waters have scale-forming matter varying not only in quantity but also in composition, the proportion of chemical reagent used should of necessity vary, depending on the analyses of the waters and the quantity taken at each water station. For this reason, boiler compounds are very objectionable unless only the necessary reagents are used in preparing the compound, necessitating a different compound for each different water, an impracticable thing to be considered in locomotive operation.

Soda ash usually gave better results than compounds of unknown composition, and was more widely used in practice. By the use of soda ash in the proper proportion, the sulphates of lime and magnesia, held in solution in the water, were decomposed, precipitating the insoluble carbonates of lime and magnesia and increasing the soluble sulphate of soda, giving the boilers a greater tendency to foam. The bicarbonates of lime and magnesia were precipitated within the boiler in the insoluble carbonate form, the heat driving off the carbonic acid that held them in solution. Under the best use of this method of softening water, the enginemen were instructed as to the proper amount of reagent to use at each water station for a given quantity of that particular water. Owing to the crude methods of determining the quantity of water taken and of measuring the amount of reagent, the result was usually a deficiency or an excess of reagent with a corresponding tendency to either form scale or to greatly increase the foaming nature of the water. The greater portion of the reaction took place within the boilers requiring more frequent blowing off, changing of water and boiler washing on account of the concentration of the foaming salts as well as the accumulation of mud in the boiler. Among the best authorities it has been conceded that the practice of treating the waters within the boilers is extremely objectionable.

In order to secure more uniform results in treating water and have reaction take place outside of the boiler, thereby relieving it of the accumulation of mud, scale and other damaging materials, the modern mechanical water-softener has been evolved. One of the principal features of a modern water-softener is the method of controlling the amount of reagents introduced with the water. In all plants the reagents are first weighed out and dissolved in solution tanks in the proper proportion, as directed by the chemist. The mechanical devices for introducing these solutions into the untreated water are various, but the intent is to have the flow of the solutions automatically regulated so as to always be in constant proportion to the flow of water into the softener. This constant proportion is best maintained when this portion of the device is least subject to wear in its parts, providing it is otherwise correctly designed. As the efficiency

of a softener depends partially on this device and the uniformity of results almost wholly (assuming that solutions are properly prepared), the importance of having good practical design in this part of the apparatus cannot be overestimated.

TYPES OF SOFTENERS.

Two general types of softeners have been designed—the continuous and the intermittent. In the continuous type, the natural water is introduced into the softener, passing through one or more chambers and finally flowing off into the regular storage tank, the sludge being precipitated to the bottom of the softener and drawn off by means of a valve from time to time, as necessary.

In the intermittent type the water passes into settling tanks, from whence it is drawn off by pumping or gravity after reaction has taken place and the solids have been precipitated.

A modification of the intermittent type is used on some railroads by utilizing the regular storage tanks for settling purposes, but unless full time is given for reaction and settlement prior to the water being drawn off into locomotives, this form will not give the same economical results as either of the other forms. The control of reagents may be good, but a portion of the reaction will take place in the boiler, with a consequent increase in mud deposited.

Practical experience with the better-designed types of both the continuous and intermittent plants has shown that there is no difference in the efficiency of water-softening, providing the mechanical devices for control of the reagents are properly designed and the correct proportions given to the other parts of the plants.

In either type of softener it is essential that sufficient time should elapse between the introduction of the water into the softener and its transfer to the storage tank, to obtain proper reaction and precipitation. There are many plants in operation at present, which are a disappointment to the officials, mainly because this important feature has been overlooked, and the actual capacity for a thorough treatment of the water is very much less than the rated capacity.

Practice has demonstrated that between three and four hours is necessary for reaction and precipitation, depending largely on the temperature of the water and the composition of the scaling matter held in solution. Water taken from running streams in winter should have at least four hours' time. In all softeners there should be some form of filter for water to pass through before finally passing into the storage tank, in order to eliminate any flakes of scale or mud forming matter that still may be held in suspension.

The hourly capacity of a water-softener is the average quantity of treated water that it can furnish to the storage tanks per hour with constant operation of the plant. In both types of softeners there is a certain portion of the plant intended to receive the precipitated matter or "sludge." The portion of the plant above this, in which the reaction takes place, determines the capacity of the plant, assuming proper design in the mechanism of the softener.

In a continuous softener, the volume of the chambers through which the water passes, between the top of the portion reserved for sludge and the outlet through which the water finally flows to the storage tank, should be at least three times the hourly capacity of the plant, and where the temperature of the water is low, it should be four times the hourly capacity.

The determination of the number and volume of settling tanks for intermittent softeners is a more complex problem. It depends on the number of pumps, or batteries of pumps, necessary to handle the water; time required to fill or empty each settling tank, above the sludge line, and time necessary for reaction and precipitation.

An ideal situation for either type of water-softener would be one where the water would flow by gravity into the softener and also from the softener into the storage tank, requiring no pumps for the handling of the water.

In the majority of cases pumps will be needed with intermittent plants as follows:

One pump only is necessary.

(1) Where water is pumped to settling tanks and is transferred by gravity to storage tanks.

(2) Where water flows by gravity to settling tanks, and is transferred to storage tank by pumping.

(3) Where water is pumped to both the settling and storage tanks and the source of supply is ample to furnish double the capacity of the softening plant.

Two pumps are necessary.

(4) Where deep well pumps furnish supply and water must be pumped from settling tanks to storage tanks.

(5) Where water is handled by pumping to both settling and storage tanks, but the source of supply is not ample to furnish at least double the capacity of the plant.

In all of the cases where pumps are needed, excepting the third case, the capacity of each pump, or battery of pumps, used for each operation should be equal to at least the treating capacity of the softener. If the pumps used to transfer the treated water are of a larger capacity, so that water can be transferred to storage tanks in less time than is required to fill the settling tanks, less settling tank capacity, will be required.

In the third case given above, as the pump must handle the water twice in its transfer from the source of supply, through the softener and into the storage tank, its capacity must be at least equal to double the capacity of the softener, and the supply must be sufficient for the pump.

At least three feet of the bottom of each settling tank should be reserved for the accumulation of the precipitates; therefore, in estimating the settling space needed and the capacity of settling tanks, the settling space should be considered as lying entirely above this reserved portion.

With these points in mind, the proper capacities for settling tanks, measured above the space reserved for sludge, can be determined as follows:

a = capacity of softener in gallons per hour.
b = hours required for reaction and precipitation.
c = number of settling tanks (never less than 2).
x = number of hours required to fill the portion of settling tank above the "sludge" portion.
y = number of hours required to transfer treated water from one settling tank to the storage tank. (y should never be greater than x.)

In case 3, before given, where one pump alternates between filling and emptying settling tanks, the time for filling and emptying the total number of tanks less one must equal the time for reaction and precipitation in that one, and x would equal y. As the capacity of the pump must be double the capacity of treating plant, the settling capacity in each tank would be $2ax$.

The equations expressing the above are:

$$2x\ (c-1) = b$$

$$x = \frac{b}{2c-2}$$

$$\text{Settling capacity each tank} = 2ax \frac{2ab}{2c-2} = \frac{ab}{c-1}.$$

For plants where the quantity of water supplied to the softener and the capacity of the plant are equal, the settling capacity of each tank is equal to ax. The total number of hours required to fill all the settling tanks should equal the number of hours required to fill, precipitate and empty one tank, as expressed by the following equation:

$$cx = x + b + y$$
$$x\ (c-1) = b + y$$

$$x = \frac{b+y}{c-1}.$$

If $y = x$, then $x = \frac{b}{c-2}$; and $ax = \frac{ab}{c-2}$.

If $y = \frac{1}{2}x$, then $x = \frac{b}{c-1.5}$; and $ax = \frac{ab}{c-1.5}$.

Table No. 1 is developed from these equations and gives the proper settling capacity per 1,000 gallons per hour capacity of treating plant under various conditions and varying number of settling tanks. From this table it can be seen that with the same time allowed for reaction and precipitation, the least number and smallest capacity of settling tanks is required where the flow of the untreated water to the softener is double the hourly capacity of the softener, and the one pump works alternately filling and emptying these tanks. Where pumping is a necessity and sufficient supply can be obtained, this one pump plan will be the cheapest and most economical in maintenance and operation of the intermittent plants.

PROPER SETTLING CAPACITY OF TANKS ABOVE THE PORTION RESERVED FOR SLUDGE, UNDER VARIOUS CONDITIONS OF OPERATION OF INTERMITTENT WATER SOFTENERS.

Number of Tanks "c"	Time required, Each Tank.			Settling Capacity of Tanks per 1,000 Gallons, Capacity of Softener.	
	Filling. "x"	Reaction. "b"	Emptying. "y"	Each Tank.	Total.
When flow of water to softener is double the capacity of softener.					
2	2 Hours	4 Hours	2 Hours	4,000 Gals.	8,000 Gals.
3	1 "	4 "	1 "	2,000 "	6,000 "
4	⅔ "	4 "	⅔ "	1 333 "	5,333 "
2	1½ "	3 "	1½ "	3,000 "	6,000 "
3	¾ "	3 "	¾ "	1,500 "	4,500 "
4	⅜ "	3 "	⅜ "	1 000 "	4,000 "
When flow of water to softener equals the capacity of softener.					
3	4 Hours	4 Hours	4 Hours	4,000 Gals.	12,000 Gals.
4	2 "	4 "	2 "	2,000 "	8,000 "
5	1⅓ "	4 "	1⅓ "	1,333 "	6,667 "
6	1 "	4 "	1 "	1,000 "	6,000 "
3	8 "	4 "	4 "	8,000 "	16,000 "
3	2⅔ "	4 "	1⅓ "	2.667 "	8,000 "
4	1⅔ "	4 "	⅔ "	1,600 "	8,400 "
5	1⅓ "	4 "	⅔ "	1,143 "	5,714 "
3	3 "	3 "	3 "	3.000 "	9,000 "
4	1½ "	3 "	1½ "	1,500 "	6,000 "
5	1 "	3 "	1 "	1,000 "	5,000 "
3	6 "	3 "	3 "	6,000 "	18.000 "
3	2 "	3 "	1 "	2,000 "	6,000 "
4	1½ "	3 "	½ "	1,200 "	4,800 "
5	⅔ "	3 "	⅔ "	857 "	4,286 "

TABLE NO, 1.

RELATIVE ECONOMY OF CONTINUOUS AND INTERMITTENT SOFTENERS.

Considering that both types are properly designed and equally efficient in treating water, the only method of comparing their economy is to consider the total annual cost of each. This cost would embrace interest charges, depreciation, running repairs, labor and fuel or power charges. These items will vary depending on the type of plant used, materials used in construction, and the local cost of labor and materials. The points to be considered under each item are as follows:

INTEREST: The annual interest on the cost of the plant installed, plus the interest on the value of ground space occupied by the plant wherever such item is of consequence.

DEPRECIATION: A sum per annum, which, if placed in a sinking fund at the estimated interest rate, will amount to the cost of plant installed, less the value of scrap material recovered at the expiration of the life of the plant (see table, page 16, Kent's Mechanical Engineer's Pocketbook).

RUNNING REPAIRS: Should include the average annual expense required for repairs to structure and machinery to give it the estimated useful life. Quiet, smooth-running mechanical parts will require less repairs to the plant than where there are violent shocks or heavy vibrations.

LABOR: The only labor that can be consistently considered is the additional labor required to operate the plant over and above the amount of labor that would be required to supply the storage tanks with the natural water at the same rate that this water is supplied to the softener.

FUEL OR POWER: This item is to be considered the same as the previous item, being only the additional fuel or power required because of the plant.

Knowing the local values for the foregoing items, it will be a simple matter to approximate the relative economical value of the different types of softeners.

REAGENTS USED IN WATER-SOFTENING.

Before considering the economical value of water-softening, it will be necessary to consider the reagents used and the quantity of reagents needed. Table No. 2 gives the quantity of reagents needed to remove one pound of incrusting or corroding matter from the water, also the effect of foaming quality of the water.

The first portion of the table considers the use of lime and soda ash as reagents, these being the cheapest and, at the present time, the most common in use. The great objection to the use of soda ash is the increase in the foaming tendency of the water. The latter portion of the table gives the quantity of barium hydrate required to treat the carbonates and sulphates of lime and magnesia. The foaming tendency of water is not increased by the barium hydrate treatment, hence its advantage over soda ash as a reagent.

QUANTITY OF PURE REAGENTS REQUIRED TO REMOVE ONE POUND OF INCRUSTING OR CORROSIVE MATTER FROM THE WATER.

Incrusting or Corrosive Substance Held in Solution	Amount of Reagent. (Pure.)	Foaming Matter Increased.
Sulphuric acid	0.57 lb. lime plus 1.08 lbs. soda ash	1.49 lbs.
Free carbonic acid	1 27 lbs. lime	None
Calcium carbonate	0.56 lb lime	None
Calcium sulphate	0 78 lb soda ash	1.04 lbs.
Calcium chloride	0 96 lb soda ash	1.05 lbs.
Calcium nitrate	0 65 lb. soda ash	1.04 lbs.
Magnesium carbonate	1.33 lbs. lime	None
Magnesium sulphate	0.47 lb. lime plus 0.88 lb soda ash	1.18 lbs.
Magnesium chloride	0 59 lb. lime plus 1.11 lbs. soda ash	1.22 lbs.
Magnesium nitrate	0 38 lb. lime plus 0.72 lb. soda ash	1.15 lbs.
Calcium carbonate	1 71 lbs. barium hydrate	None
Magnesium carbonate	4 06 lbs. barium hydrate	None
Magnesium sulphate	1.42 lbs barium hydrate	None
*Calcium sulphate	1 26 lbs barium hydrate	None

*In precipitating the calcium sulphate, there would also be precipitated 0.74 lb of calcium carbonate or 0 31 lb. of magnesium carbonate, the 1.26 lbs. of barium hydrate performing the work of 0.41 lb. of lime and 0.78 lb of soda ash, or for reacting on either magnesium or calcium sulphate, 1 lb. of barium hydrate performs the work of 0.33 lbs. of lime plus 0.62 lb. of soda ash, and the lime treatment can be correspondingly reduced.

TABLE NO. 2.

Barium hydrate has no advantage over lime as a reagent to precipitate the carbonate of lime and magnesia and should not be considered as a reagent for these substances except in connection with the treating of water containing calcium sulphate. If there were no carbonates of lime and magnesia in the water, the combination of the calcium sulphate with the barium hydrate would produce calcium hydrate and barium sulphate. Calcium hydrate is soluble in water at ordinary temperatures to an extent of about 95 grains per gallon; therefore, the water would still be hard. Barium carbonate, if easily soluble, would react on the calcium sulphate and precipitate the incrusting matter. Barium carbonate is, however, only very slightly soluble, but can be produced in a form that will react on the calcium sulphate, by the combination of the barium hydrate with either magnesium or calcium carbonates, producing barium carbonate as one of the results of reaction, and if this reaction be carried out in the presence of calcium sulphate, the barium carbonate is not precipitated but reacts on the calcium sulphate before it can separate out of the solution. For each pound of calcium sulphate removed by such reaction there would be removed an amount of the calcium and magnesium carbonates which would have required 0.41 lb. of lime, and the lime treatment can be correspondingly reduced.

In calculating the quantity of reagents necessary where barium hydrate is used in place of soda ash, the full quantity of lime should be calculated for the calcium and magnesium carbonates, and from this should be deducted 0.33 lb. of lime

for each pound of barium hydrate required on account of the calcium sulphate.

Knowing the analysis of a water, the pounds of incrusting or corrosive matter held in solution per 1,000 gallons can be obtained by dividing the grains per gallon of each substance by seven, or the parts per 100,000 by twelve.

By using Table No. 2, the quantity of reagents per 1,000 gallons can be readily calculated, and by applying local cost of the same, the cost for chemicals per 1,000 gallons will be obtained. In order to know the full amount of lime necessary, the amount of free carbonic acid contained in the water should be determined, as well as the solids contained in solution, since this free acid must be eliminated in order to obtain efficient treatment of water and reduce scaling matter to the minimum.

MINIMUM AMOUNT OF SCALING AND CORROSIVE MATTER WHICH WILL JUSTIFY TREATMENT.

The amount of incrusting solids going into boilers daily from any water station depends on the analysis of the water and the quantity of water used from that station, hence the minimum amount of scaling matter which will justify treatment cannot be stated in terms of analysis alone, but should be stated in terms of pounds incrusting matter held in solution in a day's supply. Neither can the composition of this minimum of scaling matter be definitely stated, since it requires a greater amount of reagents and much more expensive ones to treat the sulphates of lime and magnesia than to treat the same quantity of carbonates, as shown by Table No. 2. Besides the scale-forming solids, nearly all water contains more or less free carbonic acid. Sulphuric acid is also found in waters, particularly in streams adjacent to coal mines. While this does not form incrusting matter, very serious trouble from corrosion will result from a small amount of this acid.

In treating waters, the acids can be neutralized, and the incrusting matter can be reduced to at least 5 grains per gallon in most cases. Knowing the analysis of the water and the average quantity used daily, the pounds of matter that can be removed daily at any particular water station can be readily determined, and the quantity and cost of chemicals per day or per annum calculated.

The other expenses to be considered are interest on cost of treating plant, depreciation, running repairs, additional labor and fuel or power to operate the plant. As already explained, the expense for these items will vary, depending on the type of plant used, actual capacity of plant, materials used in construction and the local cost of labor and materials.

The benefits received from the softening of water will also vary, depending mainly on the amount of incrusting or other injurious matter removed from the boiler. The principal benefits, and the ones most readily converted into money value, are the reduction in cost of boiler repairs, saving in feul, and increased service obtained from the locomotives, due to less frequency of shopping. Engine failures, with consequent cost of overtime, will be reduced and a number of minor annoyances and expenses will be avoided.

In estimating the benefits, due to the removal of incrusting solids prior to the introduction of the water into the boilers, it must be remembered that carbonates of lime and magnesia, without the presence of either the sulphates of lime and magnesia, do not form hard scale, but are precipitated in boiler as soft scale and mud, which can be removed for the most part by washing out and blowing off. A very small portion of either of these sulphates, in combination with the carbonates, will cause a hard, troublesome scale and increase the expense of boiler maintenance. With clean boilers, less fuel will be necessary to evaporate a given amount of water. Authorities differ regarding the increased amount of fuel required for a given amount of scale, but a conservative estimate seems to be about 10 per cent. increase for each $\frac{1}{8}$-in. of scale.

The average locomotive with an average steam coal evaporates approximately one gallon of water per square foot of heating surface per hour. However, the full saving of fuel will not be made if the foaming solids of the water have been increased, as more water will have to be evaporated. To understand this fully we must consider the effects on operating expenses of water containing foaming solids. Where matter is held in suspension in water, priming or foaming begins at an earlier concentration of matter in solution than if no suspended matter be contained in boiler. In actual practice it is found that with a concentration of about 100 grains of foaming solids per gallon in locomotive boilers, trouble from foaming will begin. In order to avoid this trouble, the boilers must be blown off and new water admitted to take the place of this wasted water.

Water containing 10 grains of foaming solids per gallon will have reached the critical concentration on the tenth filling of the boiler; therefore to reduce to the original concentration, the water should be completely changed, i. e., one-tenth or 10 per cent of water taken in the boiler would be blown off and wasted. For fifty grains per gallon of foaming solids, 50 per cent would be wasted, as after one boiler full had been evaporated, the water would have reached the critical point.

From this it can be seen that the grains per gallon of foaming solids practically represent the per cent of water that must be wasted by blowing off, as the concentration reaches the critical point. In practice it would probably exceed this, as it would not be policy to blow off large amounts at one time when on the road, on account of the disadvantage of admitting large quantities of cold water to take its place.

If natural water containing 10 grains of foaming solids has this quantity raised to 20 grains by using soda ash as a reagent, there would be a minimum of 20 per cent. water wasted to keep it below the critical point, while only 10 per cent would be wasted if treated with barium hydrate. Therefore, the grains increase per gallon of sodium sulphate caused by using soda ash as a reagent represents the minimum per cent. point, while only 10 per cent would be wasted if the water was not treated, or if barium hydrate was used as a reagent instead of soda ash. Therefore, the grains increase per gallon of sodium sulphate caused by using soda ash as a reagent represents the minimum per cent of water wasted in changing boiler waters over what would be wasted if water were not softened, or if barium hydrate were used as a reagent. The minimum waste would be represented by the total cost of pumping and treating this wasted water by soda ash plus the cost of the fuel required to raise this water from the temperature of feed water to the temperature of the water in the boiler.

For an increase of one pound foaming matter per thousand gallons of feed water, it would be the total cost of pumping and treating 70 gallons of water, and the fuel for heating the same to temperature of boiler water.

COMPARATIVE VALUES OF BARIUM HYDRATE AND SODA ASH AS REAGENTS.

As shown by Table No. 2, for every pound of calcium or magnesium sulphates removed by the use of soda ash as a reagent, the foaming solids of water are increased 1.04 and 1.18 lbs., respectively.

Where there is already a considerable quantity of foaming matter in the water, or where there are large amounts of these scale-forming sulphates to be treated, this increase in tendency to foam may be very objectionable. Barium hydrate as a reagent does not increase the tendency to foam, hence its advantage over soda ash. In treating either calcium sulphate or magnesium sulphate, one pound of barium hydrate performs the work of 0.33 lb. of lime and 0.62 lb. of soda ash. As already explained, a portion of the carbonates of lime and magnesia will be precipitated in treating sulphate of lime, and the lime treatment correspondingly reduced. At the present time barium hydrate is a much more expensive reagent than soda ash, but owing to its superiority as a reagent, chemists are experi-

menting to devise practical methods of producing it at a cost that will not make it prohibitive. The amount that railroads can pay for this material above the cost of soda ash depends entirely on the value of keeping foaming solids down.

WATER TREATMENT BY ELECTRICITY.

A paper on water treatment by electricity was received by the committee from Mr. J. S. Campbell, engineer maintenance of way, El Paso & Southwestern Railroad, and reads as follows:

On the eastern division of the El Paso & Southwestern, the water supply is, with two or three exceptions, from deep wells, and the quality exceedingly bad, the hardness running from 40 to 180 grains per United States gallon, with the exception of that at only two or three points, at which the quality is very good.

Much of the water is also heavily impregnated with sodium salts. The Kennicott system of water softening is in use, but on account of the large amount of lime and soda ash necessary to break down the incrusting solids, and the presence of the sodium salts already in the water, it is not practicable to get the hardness below about 20 grains per gallon, on account of the foaming of the water due to the salts originally therein, and the addition of the soda ash in the treatment.

During the past few months, experiments in electrical treatment of the water have been under way. This treatment consists in submerging aluminum or iron plates in the water to be treated, and passing electrical currents through the same. It has been demonstrated that with clean plates, satisfactory results are secured, except in the matter of cost, which is very high. The experiments have not extended far enough to be able to submit definite figures of cost. It appears that on account of the quality of the water, the cost of the electrical treament would be justified, provided the efficiency of the treatment could be maintained. It is found, however, that the plates incrust quite rapidly, and the efficiency of the treatment quickly falls off after the plant has been in operation for a few days, beginning with clean plates.

As an index of the results obtained so far, the hardness of the water at Alamogordo is 40 grains per gallon. During the first three or four days of the treatment, this hardness was reduced to seven grains per gallon. As the operation was continued and the plates incrusted, the efficiency fell off until at the end of a week or ten days the hardness of the water had risen to 20 grains per gallon, at the end of the same periods of treatment which, in the beginning, reduced the hardness to seven grains. Iron plates give practically the same results.

At Pastura the water has a hardness of 180 grains per gallon, and at the present writing this has been readily reduced by iron plates to a hardness of 90, at which point the reduction has stopped. It appears, however, that by increasing the time and intensity of the treatment, it will be possible to still further reduce this, but these experiments are not yet completed.

Outside the question of cost, the problem appears to be one of cleaning the incrustation from the plates at frequent intervals after a given plant has been placed in operation. In an experimental plant having a capacity of 125,000 gallons of water treated in 24 hours, being ereceted at Alamogordo, there will be 27,000 square feet of plate, or 54,000 square feet of plate surface. These plates are three feet square, and the experiments to date indicate that they will have to be cleaned at the rate of one plate per minute during the operation of the plant in order to keep the latter up to its full efficiency. Evidently this would have to be done by machinery, and apparently this is a point that may render the process impracticable.

It has been demonstrated that, with clean plates, the hardness of the water can be reduced very much below that possible by the use of lime and soda ash, on account of the trouble of foaming when the latter treatment is carried to the excess required for these very bad waters. The electrical treatment does not increase the priming tendency of the water; in fact, it has a slightly beneficial effect.

In the reduction of the water at Alamorgordo, from 40 grains to seven grains per gallon of incrusting solids, the power required was 7 electric horsepower-hours per 1,000 gallons of water treated, the potential of the electric current being from 100 to 125 volts.

In the experiment at Pastura, the power required was just double the above.

The experimental plant at Alamogordo consists of three vats or tanks, 3 ft. deep, 5 ft. wide, and 80 ft. long, each divided into 25 compartments, in which the 3 by 3 foot plates were set on edge, and spaced one inch center to center, all the sections in each vat and the several vats being connected by proper electrical wiring. The vats are then filled with water and the electrical current turned on.

At one end of the vats there is a storage or supply tank, and at the other a precipitating tank from which the water is pumped through a filter to the railroad service tank. The perfectly treated water is a clear, limpid and very pleasant drinking water.

Apart from the apparent physical impracticability of the constant removal, cleaning and replacement of the iron or aluminum plates necessitated by the requirements of constant cleaning, this process would appear to be the most efficient of any system of treatment under the exceptional conditions obtaining on the eastern division of the Southwestern.

For the treatment of the water at Alamogordo above specified, it appears that the loss of weight of the aluminum plates is at the rate of about ¾ pound to 1,000 gallons of water treated. The experiments with the iron plates have not proceeded far enough to determine the loss from them. The incrustation of the plates is similar in a general way to the incrusting of locomotive boiler tubes, except that the scale is not nearly so hard, but still requires the application of a scraper to remove it.

The sludge precipitated from the treatment is of very fine flocculent matter of milky color.

CONCLUSIONS.

The greatest efficiency in the operation of a water-softening plant is produced by observing the following conditions:

(1) The solutions containing the reagent must be properly prepared.

(2) The reagents should be as near chemically pure as practicable.

(3) The mechanical device for introducing reagents must be such as to insure as pear as possible a quantity of reagent in direct proportion to the flow of the untreated water.

(4) Where lime and soda ash treatment are used the volume of space for reaction and precipitation must be at least from three to four times the hourly capacity of softener, depending on temperature and analysis of the water.

The equations for determining this space for both types of softener and Table No. 1, given in the body of the report, conform to good practice.

The relative economy of the different types of water softeners can be determined by comparing the total annual cost of each, excluding the cost of chemicals. This annual cost would be composed of:

Interest on the sum of the cost of installation and value of ground space occupied;

Depreciation;

Current running repairs;

Additional labor and fuel required above the ordinary cost of operating the water station.

Table No. 2, giving the quantity of reagents required per unit of scaling or corroding substance held in solution, should be approved as correct and representing good practice.

Where the commercial product is not chemically pure, the proportion of reagents should be increased to correspond with an equivalent quantity of pure reagent.

Water having foaming matter in solution requires changing

as the concentration of foaming solids in locomotive boilers reaches the critical point, i. e., about 100 grains per gallon.

The grains per gallon of foaming matter in solution, represent the minimum amount of water wasted in locomotive boilers by blowing off and changing waters.

Treatment by soda ash increases foaming matter in solution, with a corresponding per cent increase in water wasted equivalent to at least the grains increase of foaming matter per gallon.

For each pound additional foaming matter per 1,000 gallons of water, the increased expense would be equal to the cost of pumping and treating at least 70 gallons of water, and the fuel for heating the same to the temperature of boiler water. In addition to this expense, would be the damage incurred to boilers by introducing cold feed water to replace water blown out, with the consequent cooling of tubes and sheets.

The minimum quantity of solids in solution that will justify treatment depends on local conditions. By applying the proper local values to the equation given in the body of the report, this quantity can be determined.

Barium hydrate as a reagent does not increase the foaming tendency of the water. By applying the proper values to the equations given, the cost at which the use of barium hydrate would be an economy can be determined.

Masonry

In appointing the sub-committee to co-operate with the joint committee on concrete and reinforced concrete, the committee reports the appointment of Messrs. A. O. Cunningham, C. W. Boynton, G. F. Swain, C. H. Moore and G. H. Scribner, Jr., the first three are voting members and the last two are alternates.

The committee reports progress on the following three subjects. These three subdivisions are under investigation by the joint committee on concrete and reinforced concrete, with which committee we are co-operating. We suggest that the subject be reassigned for the coming year, and it is believed that a report can be made at the next annual convention.

Investigate and report upon the most economical size or combination of sizes for stone to be used in stone concrete as applied to the different classes of work. This may be a portion of the work of the sub-committee.

Collect data upon the reported failures of concrete structures and the probable causes of same. This may be assigned to the sub-committee, if thought desirable.

Investigate and report upon the waterproofing of masonry methods, results, cost and recommended practice.

Stone masonry specifications presented at the last annual convention have been revised and are submitted herewith.

SPECIFICATIONS FOR STONE MASONRY.

GENERAL.

1. Where cement and concrete are referred to in these specifications, the American Railway Engineering and Maintenance of Way Association's standard specifications for cement and concrete shall apply.

2. Where the term "Engineer" is used in these specifications, it refers to the engineer actually in charge of the work.

3. Optional clauses in these specifications are indicated by an asterisk (*.)

GENERAL REQUIREMENTS.

4. Stone masonry shall be built of the kinds specially designated, with such arrangement of courses and bond as indicated on the drawings or as directed by the engineer. Stone shall be hard and durable, free from seams or other imperfections, of approved quality and shape, and in no case have less bed than rise; it shall be laid on its natural bed, well bonded and solidly bedded. When liable to be affected by freezing, no unseasoned stone shall be laid.

5. Dressing shall be the best of the kind specified.

6. Beds and joints or builds shall be square with each other, and dressed true and out of wind. Hollow beds shall not be allowed.

7. Stone shall be dressed for laying on natural beds.

8. Marginal drafts shall be neat and accurate.

9. Pitching shall be done to true lines and exact batter.

10. Mortar shall be mixed in a suitable box, and kept clean and free from foreign matter. Sand and cement shall be mixed dry and in small batches in proportions as directed by the engineer, water then to be added and the whole mixed until the mass of mortar is thoroughly homogeneous and leaves the hoe clean when drawn from it. Mortar shall not be retempered after it has begun to set. Mechanical mixing, to produce the same results, may be permitted.

11. Stone shall be cleansed and dampened before laying.

12. Stone shall be laid on its natural bed. Each stone shall be settled into place in full bed of mortar.

13. Stone shall be laid to exact lines and levels to give the required bond and thickness of mortar in beds and joints.

14. Stone shall not be dropped or slid over the wall, but shall be placed without jarring stone already laid.

15. Heavy hammering shall not be allowed on the wall after a course is laid.

16. Stone becoming loose after the mortar is set shall be relaid with fresh mortar.

17. Stone shall not be laid in freezing weather, unless directed by the engineer. If laid, it shall be freed from ice, snow or frost by warming; the sand and water used in the mortar shall be heated.

18. With precaution, a brine may be substituted for the heating of the mortar. The brine shall consist of one pound of salt to eighteen gallons of water, when the temperature is 32 degrees Fahrenheit; for every degree of temperature below 32 degrees Fahrenheit, one ounce of salt shall be added.

19. Before the mortar has set in beds and joints, it shall be removed to a depth of not less than one inch. Pointing shall not be done until the wall is complete and mortar set, or when frost is in the stone.

20. Mortar for pointing shall consist of equal parts of sand and portland cement. In pointing, the joints shall be wet and filled with mortar, pounded in with a "set-in" or calking tool and finished with a beading tool the width of joint, used with a straight-edge.

CLASSIFICATION.

21. Stone masonry shall be classified under the following heads: bridge and retaining wall masonry, arch masonry, culvert masonry, and dry masonry.

BRIDGE AND RETAINING WALL MASONRY.

22. Bridge and retaining wall masonry shall consist of two classes: class A (Ashlar stone, either coursed or broken coursed); class B (rubble stone).

BRIDGE AND RETAINING WALL MASONRY, CLASS A.

23. In bridge and retaining wall masonry, class A, the stone shall be large and well-proportioned.

24. Courses shall not be less than 14 in. or more than 30 in. thick, thickness of courses to diminish regularly from bottom to top.

25. Beds and joints or builds of face stone shall be fine-pointed, so that the mortar layer shall not be more than ½ in. thick when the stone is laid.

26. Joints in face stone shall be full to the square for a depth equal to at least one-half the height of the course, but in no case less than 12 in.

27. Exposed surfaces of the face stone shall be rock-faced, and edges pitched to true lines and exact batter; the face shall not project more than 3 in. beyond the pitch line.

28. Chisel drafts 1½ in. wide shall be cut at exterior corners.

29. Holes for stone hooks shall not be permitted to show in exposed surfaces. Stone shall be handled with clamps, keys, lewis or dowels.

30. Stretchers shall not be less than 4 ft. long and have at least one and a quarter times as much bed as thickness of course.

31. Headers shall not be less than 4 ft. long, shall occupy one-fifth of face of wall, shall not be less than 18 in. wide in face, and where the course is more than 18 in. high, width of face shall not be less than height of course.

32. Headers shall hold in heart of wall the same size shown in face, so arranged that a header in a superior course shall not be laid over a joint, and a joint shall not occur over a header; the same disposition shall occur in back of wall.

33. Headers in face and back of wall shall interlock when thickness of wall will admit.

34. Where the wall is 3 ft. thick or less, the face stone shall pass entirely through. Backing shall not be allowed.

*35-a Backing shall be large, well-shaped stone, roughly bedded and jointed; bed joints shall not exceed 1 in. At least one-half of the backing stone shall be of same size and character as the face stone and with parallel ends. The vertical joints in back of wall shall not exceed 2 inches. The interior vertical joints shall not exceed 6 in. Voids shall be thoroughly filled with (*) concrete or spalls fully bedded in cement mortar.

*35-b. Backing shall be of (*) concrete headers and stretchers, as specified in paragraphs 30 and 31, and heart of wall filled with concrete.

34. Where the wall will not admit of such arrangement, stone not less than 4 ft. long shall be placed transversely in heart of wall to bond the opposite sides.

35. Where stone is backed with two courses, neither course shall be less than 8 in. thick.

38. Bond of stone in face, back and heart of wall shall not be less than 12 in. Backing shall be laid to break joints with the face stone and with one another.

39. Coping shall be dimension stone, holding full size throughout, proportioned for its loading, as indicated on the drawings.

40. Beds, joints and top shall be fine-pointed.

41. Location of joints shall be determined by the position of the bed plates, and be indicated on the drawings.

42. Where required, coping stone, stone in the wings of abutments, and stone on piers shall be secured together with iron cramps or dowels, their position being indicated on the drawings.

BRIDGE AND RETAINING WALL MASONRY, CLASS B.

43. In bridge and retaining wall masonry, class B, the stone shall be roughly squared, and laid in irregular courses.

44. Beds shall be parallel, roughly dressed, and the stone laid horizontal in the wall. Face joints shall not be more than 1 in. thick. Bottom stone shall be large, selected flat stone.

*45-c. The wall shall be compactly laid, having at least one-fifth the surface of back and face headers arranged to interlock, having all voids in the heart of the wall thoroughly filled with (*) concrete or suitable stones and spalls, fully bedded in cement mortar.

ARCH MASONRY.

46. Arch masonry shall consist of two classes: class A (Ashlar stone, either coursed or broken coursed); class B (rubble stone).

ARCH MASONRY, CLASS A.

47. In arch masonry, class A, voussoirs shall be full size throughout and dressed true to templet, and shall have bond not less than thickness of stone.

48. Joints of voussoirs and intrados shall be fine-pointed. Mortar joints shall not exceed 3/8 in.

*49-d. Exposed surfaces of the ring stone shall be (*) smooth or rock-faced, with a marginal draft.

50. Number of courses and depth of voussoirs shall be indicated on the drawings.

51. Voussoirs shall be placed in the order indicated on the drawings.

*52-e. Backing shall consist of (*) concrete or large stone, shaped to fit the arch bonded to the spandrel and laid in full bed of mortar.

53. Where waterproofing is required, a thin coat of mortar or grout shall be applied evenly for a finishing coat, upon which shall be placed a covering of approved waterproofing material.

54. Centers shall not be struck until directed by engineer.

55. Bench walls, piers, spandrels, parapets, wing walls and copings shall be built under the specifications for bridge and retaining wall masonry, class A.

ARCH MASONRY, CLASS B.

56. In arch masonry, class B, voussoirs shall be full size throughout, and shall have bond not less than thickness of voussoirs.

57. Beds shall be roughly dressed to bring them to radial planes.

58. Mortar joints shall not exceed 1 in.

59. Exposed surfaces of the ring stone shall be rock-faced, and edges pitched to true lines.

60. Voussoirs shall be placed in the order indicated on the drawings.

*61-f. Backing shall consist of (*) concrete or large stone, shaped to fit the arch, bonded to the spandrel, and laid in full bed of mortar.

62. Where waterproofing is required, a thin coat of mortar or grout shall be applied evenly for a finishing coat, upon which shall be placed a covering of approved waterproofing material.

63. Centers shall not be struck until directed by the engineer.

64. Bench walls, piers, spandrels, parapets, wing walls and copings shall be built under the specifications for bridge and retaining wall masonry, class B.

CULVERT MASONRY.

65. Culvert masonry shall be laid in cement mortar. Character of stone and quality of work shall be the same as specified for bridge and retaining wall masonry, class B.

66. One-half the top stone of the side walls shall extend entirely across the wall.

67. Covering stone shall be sound and strong, at least 12 in. thick, or as indicated on the drawings. They shall be roughly dressed to make close joints with each other, and lap their entire width at least 12 in. over the side walls. They shall be doubled under high embankments, as indicated on the drawings.

68. End walls shall be covered with suitable coping, as indicated on the drawings.

DRY MASONRY.

69. Dry masonry shall include dry retaining walls and slope walls.

RETAINING WALLS.

70. Retaining walls of dry masonry shall include all walls in which rubble stone laid without mortar is used for retaining embankments or for similar purposes.

71. Flat stone at least twice as wide as thick shall be used. Beds and joints shall be roughly dressed square to each other and to face of stone.

72. Joints shall not exceed 3/4 in.

73. Stone of different sizes shall be evenly distributed over entire face of wall, generally keeping the largest stone in lower part of wall.

74. The work shall be well bonded and present a reasonably true and smooth surface, free from holes or projections.

SLOPE WALLS.

75. Slope walls shall be built of such thickness and slope as directed by the engineer. Stone shall not be used in this construction which does not reach entirely through the wall. Stone shall be placed at right angles to the slopes. The wall shall be built simultaneously with the embankment which it is to protect.

Amendments to the Constitution

Proposed amendments to the constitution which were adopted by letter ballot during the year:

Sec. 1, Art. II.—Membership.—Change by substituting the following section:

"Sec. 1, Art. II.—Membership.—The membership of this association shall be divided into three classes, viz.: Active members, honorary members and associates."

Sec. 2, Art. II.—Change by substituting the following section:

"Sec. 2. An active member shall be a civil engineer, mechanical engineer, electrical engineer or architect, who has had not less than five years' actual experience in the location, construction or maintenance of railroads, and who at the time of application for membership is actively engaged in railroad service, in a responsible position, in charge of work connected with construction or maintenance of way and structures; or a professor of engineering in a college of recognized standing; or any railroad official who is responsible for or has supervision of railroad construction or maintenance of way and structures."

Sec. 3. Change by substituting the following:

"Sec. 3. An honorary member shall be a person of acknowledged eminence in railway engineering or management. The number of honorary members shall be limited to ten. Honorary members shall have all the rights of active members, except those of voting in convention and holding office."

Sec. 4. Change by substituting the following:

"Sec. 4. An associate shall be one who is not in the actual service of a railroad company, but whose pursuits, scientific acquirements or practical experience qualify him to co-operate with railroad engineers in the advancement of professional knowledge. Associates shall have all the rights of active members, except those of voting in convention and holding office."

Sec. 5. Add Sec. 5, as follows:

"Sec. 5. Any active member who shall leave the railroad service shall retain his membership in the association as an associate with all the privileges for associates, specified in Section 4, Article II, subject to the provisions of Section 6, Article II."

Sec. 6. Add Sec. 6, as follows:

"Sec. 6. Persons who are exclusively engaged in the sale or promotion of railroad patents, appliances or supplies shall not be eligible for nor retain membership in any grade in this association."

Sec. 7. Add Sec. 7, as follows:

"Sec. 7. An applicant to be eligible for membership in any grade shall be not less than 25 years of age."

Sec. 8. Add Sec. 8, as follows:

"Sec. 8. The board of direction shall have authority at any time, as the conditions, in its judgment, may warrant, to transfer members from one grade to another, or to drop a member from the membership list, under the provisions of Section 6, Article II."

Sec. 4, Art. III.—Admissions and Expulsions.—Change by substituting the following:

"Sec. 4. Any person, having once been a member of the association, and having, while in good standing, resigned from such membership, may, at a subsequent date, be restored to membership, without the payment of a second entrance fee; provided, his application for reinstatement is signed by five members, certifying to his fitness for re-election, and such application is favorably passed upon by the board of direction by a two-thirds majority vote of the entire board."

At the 1906 convention it was decided that amendments to the constitution be submitted to letter ballot during the year with its adoption by a vote of 145 to 12. The following sections were affected by this change:

No payment will be made for hauling material when the length of haul does not exceed the limit of free haul, which shall be ..... feet.

Section 1, Article V. Amend by adding the following clause:

"The offices of first and second vice-president shall be determined by the priority of the respective dates of election of the two vice-presidents."

The section will then read:

"Section 1. The officers of this association shall consist of a president, a first vice-president, a second vice-president, six directors, a secretary and a treasurer, who, together with the four latest living past-presidents, who are active members, shall constitute the board of direction in which the government of the association shall be vested, and who shall act as trustees and have the custody of all property belonging to the association. The offices of first and second vice-presidents shall be determined by the priority of the respective dates of election of the two vice-presidents."

Section 2, Article V. Amend by striking out the following words on the first and second lines: "The terms of office of the president and vice-presidents shall be two years," and substitute the following: "The term of office of the president shall be one year; that of the vice-presidents two years."

The section will then read as follows:

"Section 2, Article V. The term of office of the president shall be one year; that of the vice-presidents two years; that of the directors three years, and of the secretary and treasurer one year, with the exception, however, that at the first election of officers after the adoption of this constitution one vice-president and two directors shall be elected to serve one year; one vice-president and two directors for two years, and two directors for three years; provided, also, that after the first annual election, one vice-president and two directors shall be elected each year in addition to the president, secretary and treasurer."

An addition to the amendment of the section relating to membership was received by the board asking that it be submitted to letter ballot during the year.

The proposed amendment to the constitution is as follows:

Section 1, Article II., change by adding the following: "All members who are members of this association at the time of the adoption of this section shall retain their membership as active members."

Exhibits at the Convention

The exhibits displayed on the second floor of the Auditorium, Chicago, during the meeting of the American Railway Engineering and Maintenance of Way Association, were more in prominence than any previous convention and was marked with increased attendance and interest. The Road and Track Supply Association held their annual meeting on Wednesday morning, March 20, and elected officers for the ensuing year as follows:

President—John C. McKinnon, Kalamazoo, Mich.

Vice-President—F. A. Poor, Chicago.

Secretary and Treasurer—John N. Reynolds, Chicago.

Executive Committee—W. E. Clark, Portland, Ore.; J. H. Martin, Pittsburg, Pa.; William Goldie, Sr., West Bay City, Mich.; W. F. Schleiter, Pittsburg; George Stanton, Cleveland, O.; Orlando Metcalf, Jr., Chicago.

Following is the list of supply houses and their representatives that exhibited at the convention:

Adams & Westlake Co., Chicago. Railroad signaling equipment, one New York Central standard switch lamp, one train order signal lamp. Represented by G. L. Walters and H. G. Turney.

Ainsworth, William & Son, Denver, Colo. Engineer's transits and precision balances. Represented by Robert G. Ainsworth.

Allith Manufacturing Co., Chicago. Allith adjustable and fixed door hangers, track and equipment, merchandise carriers and continuous parallel door construction. Represented by W. D. Jameson and F. E. Sladden.

American Flange Frog & Railway Improvement Co., Roanoke, Va. The Graham flange frog. Represented by John E. Graham.

American Guard Rail Fastener Co., Philadelphia, Pa. The anchor guard rail clamp, tieplate guard rail fastener and the Samson rail bender. Represented by D. F. Vaughan.

American Hoist & Derrick Co., St. Paul. Photograph of steam shovels. Represented by W. O. Washburn.

American Locomotive Co., New York. Locomotives. Represented by John H. Wynne, E. M. Hall and O. L. Parsons.

American Steel & Wire Co., Chicago. Railroad fences and rail bonds. Represented by J. M. Holloway, L. P. Shanahan and H. A. Parks.

American Tracing Cloth Co., New York, N. Y. Tracing cloth. Represented by George E. Siebert.

American Valve & Meter Co., Cincinnati, O. Anderson interlocking switchstand, Poage automatic water columns and tank fixtures. Represented by N. Paul Fenner, Jr., F. C. Anderson and J. T. McGarry.

Atlantic Equipment Co., New York. Pamphlets and photographs of steam shovels. Represented by John H. Wynne, E. M. Hall and O. L. Parsons.

Atlas Railway Supply Co., Chicago, Ill. Atlas joints, braces, tieplates, switchstand. Represented by J. G. McMichael and G. M. Huber.

Barrett Manufacturing Co., New York. Waterproofing and roofing. Represented by W. S. Babock and C. P. Gooding.

Beaver Dam Malleable Iron Co., Beaver Dam, Wis. F. & N. spreader and anti-creeper; also malleable iron tieplates and rail braces. Represented by W. L. Douglas, D. P. Lamoreux, L. Fitch, A. E. Martin and W. H. Fowler

Belle City Malleable Iron Co., Racine, Wis. L. & S. anti-rail creeper and joint holders; also Murray tie spacing and straightening jack. Represented by J. H. Dwight.

F. W. Bird & Son, and Hydrex Felt & Engineering Co., Chicago. Paroid roofing. Represented by A. R. McAlpine and E. W. De Knight.

S. F. Bowser & Co., Inc., Ft. Wayne, Ind. Two self-measuring oil pumps and self-lubricating pump and tank. Represented by W. T. Simpson.

Brinker Safety Switch Attachment Co., West Lebanon, Ind. Safety switch model. Represented by C. B. Brinker and Alexander Hamar.

Wm. Brown Paint Co., Chicago, Ill. Samples of Brown's weatherproof paint. Represented by E. S. Anderson and William Brown.

Bryant Zinc Co., Chicago. Primary batteries for signal supply and crossing alarm bells. Represented by A. F. Klink and H. J. Hovey.

Buda Foundry & Manufacturing Co., Chicago, Ill. Track supplies, crossing, frogs, switch stands and hand cars. Represented by H. K. Gilbert, W. P. Hunt, E. S. Nethercut, W. M. Walsh, J. T. Harahan, Jr., W. E. Marvel and A. E. McLeod.

Cambria Steel Co., Johnstown, Pa. Sample 100 per cent rail joint. Repesented by A. Morrison.

Carnegie Steel Co., Pittsburg, Pa. Duquesne splice bar and steel cross tie. Represented by W. P. Siebert, L. C. Lustenberger, N. M. Hench, W. A. Bostwick, H. C. Griswold and E. C. Brown.

Central Iron & Steel Co., Harrisburg, Pa. Sample American steel railway tie. Represented by George L. Hall.

Chacamas Plantation Co., Chicago. Railroad tie timber. Represented by A. E. Phillips and F. R. McKinstry.

Chameleon Signal & Manufacturing Co., Edwardsville, Ill. Automatic block signal. Represented by W. A. Richardson.

Chicago Pneumatic Tool Co., Chicago. Rivet and chipping hammers, reaming boxing and drilling machines. Represented by C. V. Walker, Jr.

Chicago Steel Tape Co., Chicago, Ill. Steel tapes and leveling outfit. Represented by L. A. Nichols.

Myron C. Clark Publishing Co., Chicago, Ill. Books and papers. Represented by Parker N. Cole and A. B. Gilbert.

The Cleveland Frog & Crossing Co., Cleveland. O. Prentice anti-rail creeper and track equipment. Represented by G. C. Lucas and George Stanton.

Climax Stock Guard Co., Chicago, Ill. Climax stock yards and gates. Represented by F. W. Stewart and F. V. Stewart.

Conley Frog & Switch Co., Memphis, Tenn. Conley frog Represented by J. E. Conley.

Cook's Standard Tool Co., Kalamazoo, Mich. "Standard" track drills and tool grinders. Represented by Eugene Cook and H. W. Russell.

Cortright Metal Roofing Co., Philadelphia, Pa. Metal roofing and shingles. Represented by H. A. Follett and H. C. Bonner.

Danville Car Co., Danville, Ill. Photographs of the new plant. Represented by William Russell.

Detroit Graphite Mfg. Co., Detroit, Mich. Graphite paints. Represented by F. R. Wyles.

G. W. Dickey, Chicago, Ill. Dickey rail joint supports. Represented by G. W. Dickey.

Paul Dickinson, Inc., Chicago, Ill. Dickinson smokejacks, chimneys and ventilators. Represented by J. A. Meaden, E. W. Hodgkins and F. G. Webb.

Dilworth, Porter & Co., Pittsburg, Pa. Tie-plates and railway appliances. Represented by William Goldie, A. Morrison and W. F. Schleiter.

H. B. Dodge & Co., Chicago, Ill. Swing and rolling doors manufactured by the J. G. Wilson Manufacturing Co., New York. Represented by E. L. Palmer and W. P. Waugh.

Dressel Railway Lamp Works, New York. Signal lamps. Represented by Robert Black and J. M. Brown.

Eastern Granite Roofing Co., New York. Granite roofing. Represented by G. E. De Groat, W. F. Sachs, H. S. Cheney, A. E. Roever and S. Reid Holland.

Economy Separable Switch Point Co. Separable Switch "Economy" separable switch plant. Represented by W. M. Mitchell.

Electric Storage Battery Co., Philadelphia, Pa. Batteries for car lighting and signal service. Represented by G. H. Atkin, W. F. Bauer, H. B. Marshall and W. F. Rath.

Engineering Agency, Chicago, Ill. Represented by A. G. Frost.

Expanded Metal & Corrugated Bar Co., St. Louis. Reinforced concrete construction, bridge abutments, culverts, storage tanks, retaining walls, etc. Represented by W. C. Berry and A. C. Roeth.

Eyeless Tool Co., Newark, N. J. Eyeless picks, hammers and sledges. Represented by M. F. Wood.

Fairbanks, Morse & Co., Chicago, Ill. Inspector car, Barrett track jacks, rail drills and stand pipes. Represented by A. A. Taylor, George J. Akers, C. W. Kelley, E. M. Fisher, R. A. Paterson, A. F. Young, A. L. Abbott, H. B. Smith, J. A. Steele, C. D. Walworth, T. M. Orr, T. C. Kennedy, P. C. Jacobs, Robert Elder, W. T. Krausch, J. H. Harden, L. A. Hopkins, F. Von Schlegell, E. O. Reynold and L. Norvell

Firefight Paint Co., Pittsburg, Pa. Fireproof paints. Represented by H. R. Richter and E. A. Richter.

Flexible Compound Co., Philadelphia, Pa. Waterproof paint binder for paints. Represented by Thomas H. Downward.

Franklin Manufacturing Co., Franklin, Pa. Asbestos shingles,, corrugated lumber and smokejack materials. Represented by Wallace W. Johnson and W. C. Walsh.

General Fireproofing Co., Youngstown, O. Cold twisted lug bars for concrete reinforcing; Herringbone expanded steel lath; pin connected girder frame. Represented by H. B. McMasters, F. L. Southworth, E. N. Hunting, F. P. Kafka, A. C. Tobin and A. W. Somers.

Wm. Goldie, Jr., & Co., Bay City, Mich. Goldie perfect tie plug. Represented by William Goldie, Sr.

Goodwin Car Co., New York. Goodwin steel dump car. Represented by W. H. Safford.

Gordon Battery Co., New York. Primary batteries. Represented by W. M. Kinch and E. M. Deems.

N. Z. Graves Co., Chicago, Ill. Structural paint. Represented by H. C. Carpenter, C. W. Thomas, A. I. Stevens and W. L. Beiderman.

Greene's Railroad Safety Device Co., Buffalo, N. Y. Model of automatic safety device for facing point switches. Represented by E. F. Greene.

Grip Nut Co., Chicago, Ill. All sizes of square and hexagon grip nuts. Represented by T. F. De Garmo and R. S. Wickersham.

Hayes Track Appliance Co., Geneva, N. Y. Lifting derails, pivot derails, operating and target stand. Represented by S. W. Hayes and H. F. Nester.

S. P. Holmes, & Co., Chicago, Ill. Fireproof steel construction. Represented by S. P. Holmes and W. J. Wilson.

William B. Hough, Chicago, Ill. Ransom concrete machinery and steel sheet piling. Represented by M. C. Tompkins and O. A. Kreutzberg.

Hussey-Binns Shovel Co., Pittsburg, Pa. Shovels. Represented J. H. Martin.

H. W. Johns-Manville Co., New York. Asbestos and magnesia pipe coverings and roofing materials. Represented by H. Gilmore and Ira J. Smucker.

Kalamazoo Railway Supply Co., Kalamazoo, Mich. Hand cars, track drills, jacks, gauges and levels. Represented by John McKinnon, H. G. Haines, D. A. Moore and J. W. Thom.

Keuffel & Esser Co., New York. Full line engineering instruments and supplies, measuring tapes and chains. Represented by R. Ling and O. S. Rhea

Kinnear Manufacturing Co., Columbus, O. Rolling doors for roundhouses. Represented by A. S. Beymer and A. S. White.

B. R. Kozlowski, Chicago, Ill. Steel tie and rail fastening. Represented by B. R. Kozlowski, S. Zaleski and J. P. Zaleski.

Lackawanna Steel Co., Buffalo, N. Y. Rail fastenings, track gauges and rail joints. Represented by F. E. Abbott and D. H. Van Pelt.

The Lehon Co., Chicago, Ill. Roofing. Represented by T. B. Lehon and W. H. Allen.

Locomotive Appliance Co., Chicago, Ill. Derailer, Newton frogs. Represented by W. H. England.

Lufkin Rule Co., Saginaw, Mich. Measuring tapes. Represented by Theodore Huss, S. B. McGee and W. D. Almy.

McClintock Manufacturing Co., St. Paul, Minn. Signal appliances. Represented by C. H. Decker, R B. Farnsworth and Edw. McClintock.

McCord & Co., Chicago, Ill. Gibralter bumping post. Represented by C. L. Brackett.

The McMyler Manufacturing Co., Cleveland, O. Separable switch and Odenkirk switchboard, position switchstands, "Economy" separable switch points. Represented by W. S. Newhall and H. C. Odenkirk.

Morden Frog & Crossing Works, Chicago, Ill. Model switchstand. Protection to switch points, switchstands and continuous rail crossing, protection to facing point switches. Represented by A. C. Smith.

The National Lock Washer Co., Chicago, Ill. Nut locks. Represented by F. B. Archibald, S. E. Bake, F. B. Buss and J. B. Seymour.

National Railway Materials Co., New York. Insulated joints and rail braces. Represented by George L. Hall.

The National Roofing Co., Tonawanda, N. Y. Gravel roofing. Represented by B. G. Castler and F. A. Fuller.

Newman Clock Co., Chicago, Ill. Watchmen's clocks. Represented by F. W. Barnes and B. C. Allen.

Joseph Odien, Buffalo, N. Y. Metallic non-spreading tie. Represented by Joseph Odien.

Ohio Motor Co., Sandusky, O. Gas, gasoline and oil engines, pumping machinery. Represented by H. L. Clarke.

The Spencer Otis Co., Chicago, Ill. Tie-plate manufactured by the Hart Steel Co., of Elyria, O. Represented by W. T. Bentz and W. S. Miller.

The Otto Gas Engine Works, Chicago, Ill. Illustrations of coaling stations, gas engines, water tanks, cranes and water softening plants, handling appliances, water handling appliances, water softening plants, gasoline engines producer gas engines, etc. Represented by T. W. Snow, R. E. Gurley and H. J. Harnish.

Pennsylvania Steel Co., Steelton, Pa. Switches, frogs, signaling equipment, photographs of steel bridges. Represented by George W. Parsons, R. E. Belknap, N. E. Salsich, Captain Long, W. E. Henderson, F. A. Allen and W. C. Cuntz.

Pepple Steel Railroad Tie Co., Hillsboro, Tex. Steel tie. Represented by J. W. Pepple.

Percival Concrete Steel Tie Co., Galveston, Tex. Concrete steel tie. Represented by A. S. Heaton.

Pruyn Reinforced Concrete Railroad Tie Co. Reinforced concrete tie. Represented by W. H. Pruyn, Jr.

The Rail Joint Co., Chicago and New York. Continuous Weber and Wolhaupter standard joints. Represented by L. F. Braine, P. Holbrook, B. Wolhaupter, D. J. Evans, F. A. Poor, G. A. Hagar, S. J. Collins, E. A. Condit, Jr., W. A. Chapman, J. A. Greer, W. E. Clark, E. L. Van Dresser, J. G. Miller, Clarence Irwin, F. C. Webb, B. M. Barr, V. C. Armstrong, J. C. Barr, George W. Smith, H. C. Holloway, W. T. Smettem and F. M. Hill.

The Railroad Supply Co., Chicago, Ill. Wolhaupter, Q & W. and Serres tie-plate. Signal supplies. Represented by C. P. Cogswell, Jr., E. H. Bell, E. W. Vogel and M. J. Comerford.

Railway Specialty & Supply Co., Chicago, Ill. P. & M. rail anchor. Smith improved lock nut and Buckeye light. Represented by J. M. Brown and P. W. Moore.

Arthur E. Rendle, New York. Skylight and fireproof windows. Represented by A. E. Rendle.

Harry Raymond, Chesterton, Ind. Model of automatic self-closing switch. Represented by Harry Raymond.

Ritter Folding Door Co., Cincinnati, O. Ritter horizontal folding door. Represented by Adam Ritter and Jacob Luikart.

Roberts & Schaefer, Chicago, Ill. Photographs showing coaling station erected for various railroads, water softeners. Represented by E. E. Barrett.

Root Scraper Co., Kalamazoo, Mich. Steam and electric locomotive railway scrapers. Represented by F. N. Root, John McKinnon and H. J. Haines.

Rubberset Brush Co., Newark, N. J. Paint brushes. Represented by A. L. Holtzman.

Sandusky Portland Cement Co., Sandusky, O. Medusa water-proof compound. Represented by F. J. Morse.

William B. Scaife, & Sons, Pittsburg, Pa. Water softening, purifying and filtering systems. Represented by E. S. Woods & Co.

Scherzer Rolling Lift Bridge Co., Chicago, Ill. Scherzer rolling lift bridges. Represented by F. F. Soule, J. T. Dickerson and W. Meier.

Scott Manufacturing Co., Racine, Wis. Bumping posts and Racine rail anchor. Represented by John M. Scott and W. A. Walker.

Sellers Manufacturing Co., Chicago, Ill. Anchor bottom tie-plates and splice bars. Represented by John M. Sellers and Joseph T. Markham.

Standard Asphalt & Rubber Co., Chicago, Ill. Waterproof bridge coatings, pipe dips and mastic floors, and waterproofing of asphalt and mastic, also pipe dip. Represented by G. D. Carr and W. H. Lawrence.

Standard Cattle Guard Co., Birmingham, Ala. Steel surface cattle guard. Represented by P. G. Wright.

Arthur L. Stanford, Chicago, Ill. Stanford rail joint and

American railroad track jack, and Stanford rail joint track jack. Represented by A. L. Stanford.

Strauss Bascule & Concrete Bridge Co., Chicago, Ill. Small models of the Strauss bascule bridge. Represented by J. B. Strauss.

Taylor Iron & Steel Co., High Bridge, N. J. Panama two-part dipper tooth and manganese steel castings. Represented by Al. H. Hoffman.

Templeton, Kenly & Co., Chicago, Ill. Jacks. Represented by W. B. Templeton, W. L. O'Neill and E. T. Hendee.

William R. Thomas, Watertown, Wis. Two-piece bottless rail joint. Represented by William R. Thomas.

Truss & Cable Fence Co., Cleveland, O. Wire fence. Represented by W. D. La Parle.

United Indurated Fibre Co., of New Jersey, Lockport, N. Y. Electric third rail insulation. Represented by J. Peterson.

U. S. Blue Print Paper Co., Chicago, Ill. Tracing cloth, engineers and architects supplies. Represented by W. W. Koch, George Coffman and P. K. Ripka.

U. S. Graphite Co., Saginaw, Mich. Graphite specialties and oils. Represented by G. Douglas, J. G. Dwight and E. J. Roach.

U. S. Nut Lock Co., Ft. Worth, Tex. Lock nuts. Represented by W. D. La Parle.

U. S. Wind Engine & Pump Co., Batavia, Ill. Water tanks, switchstands and railroad water supplies. Represented by L. E. Wolcott, A. J. Anderson and R. E. Derby.

Universal Portland Cement Co., Chicago, Ill. Samples of raw material. Represented by B. F. Affleck and B. H. Rider.

Verona Tool Work, Pittsburg, Pa. Nut locks, track tools, eyeless picks. Represented by Harry Paul, O. Metcalf, Jr., and W. D. Hechler.

Weir Frog Co., Cincinnati, O. Rail clamps, switchstands, frogs and crossings. Represented by W. W. Allen and N. O. Goldsmith.

Western Railway Supply Co., Chicago, Ill. Railway supplies and safety appliances. Represented by W. E. Ackley.

C. H. Whall & Co., Boston, Mass. Track circuit insulation. Represented by F. R. Whall.

Wm. Wharton, Jr., Co., Inc., Philadelphia, Pa. Wharton guard rail clamps and manganese steel frogs and crossings. Represented by R. C. McCloy, A. S. Partridge and W. M. McLain.

James A. Willis, Libertyville, Ill. The Peerless wood cushioned steel railroad tie, wood cushioned steel railroad tie. Represented by James A. Willis.

E. J. Winslow, Chicago, Ill. Hydrolithic waterproof cement vaults, roof tiles, etc. Represented by E. J. Winslow and S. H. Price.

Julian Yale & Co., Chicago, Ill. Universal cast-iron pipe. Represented by C. L. Sullivan.

Prices of Track Materials F. O. B. Chicago

TRACK SUPPLIES.

	Mill price.
Steel Rail, 60 lbs. and over	$28.00 per gross ton
Steel Rail, 30 to 45 lbs	35.00 per gross ton
Steel Rail, 25 lbs	36.00 per gross ton
Steel Rail, 20 lbs	37.00 per gross ton
Steel Rail, 16 lbs	38.00 per gross ton
Steel Rail, 12 lbs	39.00 per gross ton
Ties, 6x8x8 oak, 1st grade	75c. each
Ties, 6x8x8 oak, 2d grade	60c. each
Switch Ties	$30.00 M. ft.

Angle bars, accompanying rail orders, 1907 delivery, 1.65c.; car lots, 1.90c. to 1.95c.; spikes, 2.40c. to 2.50c., according to delivery; track bolts, 2.75c. to 2.85c, base, square nuts, and 2.90c. to 3c., base, hexagon nuts. The store prices on track supplies range from 0.15c. to 0.20c. above mill prices. Switch set per turn out, $175 to $200.

OLD MATERIAL.

	Per Gr. Ton.
Old Steel Rails, 3 ft. and over	$19.00 to $19.50
Old Steel Rails, less than 3 ft	18.00 to 18.50
Old Iron Rails	25.00 to 26.00

SHEET STEEL.

It is quoted for future delivery:

Tank Plate, ¼-in. and heavier, wider than 6¼ and up to 100 in. wide, inclusive, car lots, Chicago, 1.86½c. to 2.06½c.; 3-16 in., 1.96½c. to 2.16½c.; Nos. 7 and 8 gauge, 2.01½c. to 2.21½c.; No. 9, 2.11½c. to 2.31½c.; Flange quality, in widths up to 100 in., 1.96½c. to 2.06½c., base, for ¼-in. and heavier, with the same advance for lighter weights; Sketch Plates, Tank quality, 1.96½c. to 2.16½c; Flange quality, 2.06½c. Store prices on Plates are as follows: Tank Plate, ¼-in. and heavier, up to 72 in. wide, 2.20c. to 2.30c.; from 72 to 96 in. wide, 2.30c. to 2.40c.; 3-16 in. up to 60 in. wide, 2.30c. to 2.40c.; 72 in. wide, 2.55c. to 2.65c.; No. 8, up to 60 in. wide, 2.35c. to 2.45c.; Flange and Head quality, 0.25c. extra.

STRUCTURAL STEEL SHAPES.

Store quotations are unchanged at 2.05c. to 2.10c., and mill prices are as follows: Beams and Channels, 3 to 15 in., inclusive, 1.86½c.; Angles, 3 to 6 in., ¼-in. and heavier, 1.86½c.; larger than 6 in. on one or both legs, 1.96½c.; Beams, larger, than 15 in., 1.96½c.; Zees, 3 in. and over, 1.86½c; Tees, 3 in. and over, 1.91½c., in addition to the usual extras for cutting to extra lengths, punching, coping, bending and other shop work.

CAST IRON PIPE.

Quotations per net ton on Water Pipe, 4 in., $38 to $39; 6 to 12 in., $37 to $38; 16 in. and up, $36 to $37, with $1 extra for Gas Pipe.

CEMENT.

	Package.
Good grade Portland Cement	$1.75 in wood 1.55 in paper *1.75 in duck

*(Duck sacks credited when returned.)

SAND.

Bank sand	$ .95 per yd.
Torpedo sand	1.30 per yd.

CRUSHED STONE AND GRAVEL.

Crushed limestone	$1.10 per yd.
Crushed gravel	1.10 per yd.

Personal Mention

Mr. A. W. Jones has been appointed assistant chief engineer of the South & Western R. R., with office at Johnson City, Tenn., and Mr. Charles L. Ruffin has been appointed division engineer at Clinchport, Va., to succeed Mr. Jones.

Major George W. Goethals has been appointed chief engineer of the Panama Canal to succeed Mr. John F. Stevens, resigned. Maj. Goethals will be assisted by Maj. D. D. Gaillard and Maj. William L. Seibert.

Mr. M. M. Birdsong has been appointed roadmaster of the Fort Worth & Rio Grande R. R., with office at Fort Worth, Tex., to succeed Mr. T. Troy, resigned.

Mr. J. J. Cozzens has been appointed assistant engineer of signals of the New York Central & Hudson River R. R., with office at Syracuse, N. Y. Mr. S. P. Hull has been appointed to a similar position, with the exception of the electric division, with office at New York.

Mr. J. G. Sullivan has been appointed manager of construction for the eastern lines of the Canadian Pacific, with office at Toronto, Ont.

Mr. L. F. Goodale has resigned as engineer of maintenance of way of the Chicago, Burlington & Quincy Ry., at St. Louis, Mo., to become supervising engineer of railroad construction in the Philippine Islands to succeed Mr. F. A. Molitor, resigned.

Mr. William J. Fripp has been appointed general superintendent of the Boston & Albany R. R. with office at Boston, Mass., to succeed Mr. J. B. Stewart.

Mr. Miles Bronson has been appointed superintendent of the New York Central & Hudson River R. R., at Weehawken, N. J., to succeed Mr. W. J. Fripp. Mr. G. VanTassell has been appointed superintendent at White Plains, N. Y., to succeed Mr. Bronson.

Mr. H. L. Hungerford has been appointed superintendent of the Southern Ry., at Charleston, S. C., to succeed Mr. A. Gordon Jones, who has been appointed purchasing agent with office at Washington, D. C.

Mr. J. M. Shea has been appointed superintendent of the Seaboard Air Line at Raleigh, N. C., to succeed Mr. W. J. Jenks, who has been transferred to Jacksonville, Fla., in place of Mr. E. L. Ryan, resigned.

Mr. W. B. Darrow has been appointed superintendent of the Southern Ry., and the St. Johns River Terminal Co., with office at Jacksonville, Fla., to succeed Mr. W. L. Pierce, resigned.

Mr. W. A. Whitney, superintendent of transportation of the Denver & Rio Grande and the Rio Grande Western, has been appointed superintendent of the Rio Grande Western, with office at Salt Lake City, Utah, to succeed Mr. George Geiger, resigned.

Mr. J. L. Walsh has been appointed acting division superintendent of the Missouri, Kansas & Texas at Parsons, Kan., to succeed Mr. J. W. Walton, resigned. Mr. Walsh heretofore has been assistant division superintendent.

Mr. J. H. Hustis, heretofore superintendent of the Hudson and Putnam divisions of the New York Central & Hudson River, has been appointed general superintendent of the Western district, with office at Syracuse, N. Y. Mr. F. T. Slack, assistant superintendent of the Hudson division, has been appointed to succeed Mr. Hustis as superintendent of the Hudson and Putnam divisions, with office at Grand Central station, New York.

Mr. F. T. Jeans has been appointed superintendent of bridges of the Houston & Texas Central at Houston, Tex.

Mr. A. Brown has been appointed general roadmaster of the Central district of the Great Northern at Minot, N. D.

Mr. J. E. Schwitzer, heretofore principal assistant engineer of the Canadian Pacific, has been appointed assistant chief engineer of the western lines, with office at Winnipeg, Man.

Mr. A. P. Cone, assistant superintendent of the Washington division of the Southern Railway, has been appointed superintendent of the Richmond division, with office at Richmond, Va., succeeding W. T. West, deceased.

Mr. George E. Waring has been appointed superintendent of the Oklahoma Central with headquarters at Byars, I. T., in place of Mr. W. J. Terry.

Mr. George W. Rohrman has been appointed supervisor of tracks of the Indianapolis Union at Indianapolis, Ind., in place of Mr. F. T. Gurley, resigned.

Mr. W. A. Beauprie has been appointed inspector of block signals on the western district of the Southern Railway, with headquarters at Birmingham, Ala.

Mr. W. T. Powell has been appointed superintendent of bridges and buildings of the Colorado & Southern, with headquarters at Denver, Colo., to succeed Mr. O. J. Travis, resigned.

Mr. M. M. Hayes has been appointed supervisor of signals of the western division of the New York Central & Hudson River at Rochester, N. Y., in place of Mr. J. J. Cozzens, promoted. Mr. John Parker has been appointed supervisor of signals of the Buffalo division at East Buffalo, N. Y.

Mr. W. C. Smith, division engineer of the Northern Pacific, in charge of the lines east of Mandan, N. D., has been appointed engineer of maintenance of way, with headquarters at St. Paul, Minn. Mr. W. C. Taylor has been appointed acting division engineer at St. Paul, in place of Mr. Smith.

Mr. R. W. Willis, heretofore division engineer of the Chicago, Burlington & Quincy at Galesburg, Ill., has been appointed engineer of the Missouri district at St. Louis, Mo., in place of Mr. A. W. Newton, who has been transferred. Mr. John C. Sesser has been appointed enengineer of maintenance of way at St. Louis, Mo., to succeed Mr. L. F. Goodale, resigned.

Mr. F. J. Egan has resigned as superintendent of the

Macon division of the Southern Railway, and Mr. W. J. Bell, superintendent of the Columbus division of the Southern, has been appointed to succeed Mr. Egan as superintendent of the Macon division, with headquarters at Macon, Ga. Mr. J. L. McLendon succeeds Mr. Bell as superintendent of the Columbus division, with office at Williamson, Ga.

Mr. L. U. Morris, superintendent of the western division of the El Paso & Southwestern, has been transferred to the superintendency of the eastern division, with office at El Paso, Tex., succeeding Mr. A. R. Oster.

Mr. J. S. Reddoch, trainmaster of the Mexican Central at Monterey, Mex., has been appointed superintendent of the Torreon division, with headquarters at Gomez Palacio, Mex.

Mr. H. S. Jones, chief engineer of the Mobile, Jackson & Kansas City, has been appointed general superintendent, with headquarters at Mobile, Ala. The office of general manager has been abolished.

Mr. J. Q. Barlow, chief engineer of the Western Maryland, has been appointed chief engineer of the Georges Creek & Cumberland also.

Mr. H. H. Harman, acting engineer of bridges of the Bessemer & Lake Erie, has been appointed engineer of bridges, with office at Greenville, Pa.

Mr. M. Elmfield has been appointed supervisor of the Toledo & Ohio Central at Kenton, O., in place of Mr. D. C. Holtsberry, who has been appointed division engineer of maintenance of way.

Mr. H. E. Newcomet has been appointed engineer of maintenance of way of the Cleveland & Pittsburg division of the Pennsylvania Lines West of Pittsburg at Cleveland, O. Mr. W. R. Hillary has been appointed engineer of maintenance of way of the Erie & Ashtabula division, with office at New Castle, Pa.

Mr. C. C. Boyer has been appointed resident engineer of the Gulf, Colorado & Santa Fe R. R., with office at Temple, Tex., to succeed Mr. M. T. Pratt, resigned.

Mr. W. L. Whiteneck has been appointed general foreman of the bridge and building department of the Red River division of the St. Louis & San Francisco R. R., with office at Francis, I. T.

Mr. E. L. Cousins has been appointed division engineer of the Grand Trunk Ry. at Toronto, Ont., to succeed Mr. G. R. McLeod, resigned.

Sarco Asphalt Roofing Material

A weather proof roofing material which is giving considerable satisfaction for uses on railroad buildings is marketed by the Standard Asphalt and Rubber Co., First National Bank Building, Chicago, Ill. The important features are its ductility, pliability, adaptability to all climatic conditions and light in weight. It does not become soft in the sun and dry out or crack and break up in cold weather. Special attention is called to its economical use for permanent repairs of car roofs and station buildings.

Beside the asphalt roofing material this company also markets a Mineral Rubber Waterproofing, Pipe Dip, and Insulation Materials, all of which are possessed with particular advantages.

The Mineral Rubber Waterproofing will stand a wide range of temperature and can be made to meet most all conditions or requirements. It is valuable for use in refrigerator cars, tunnel lining and in building operations. One favorable feature is that it will not crack and will conform to inequalities or uneven settling.

Iron and steel pipes, or structural metal of any sort, dipped in Sarco Pipe Dip are prevented from rusting and practically free from electrolysis. It also serves as a weather-proof preservative as well as making the metal more ductile, pliable, elastic and durable. It may be applied hot or cold and of any consistency the case may require. It will not become brittle and crack off and will stand moderately high temperatures.

The Sarco insulation is impervious to water and acids and is useful in obviating short circuits on the various electrically controlled systems used on railroads. It will withstand a high peripheric speed, making it useful in high speed electrical machinery. A one-eighth inch coating of this material will allow of no conductivity with voltage running as high as 12,000 volts. It may be applied to most all fabrics and will stand heat or cold with no baneful effects.

Railway Signal Battery Vaults

Among the number of different varieties of vaults arranged for railway signal batteries, the Hydrolithic Concrete Steel Vault, manufactured by the E. J. Winslow Company, Chicago, Ill., has proven to be satisfactory under most conditions.

They possess a number of advantages which make them very desirable for this service as they are of light construction water proofs, non corrosive and portable. It also has the advantage of not attracting lightning and is practically exempt of expansion and seasoning cracks. From what has been said it would appear that this type of vault would gradually gain favor over the more common wood and steel vault. In case of a workman overlooking a defect in construction before leaving the factory it can be repaired from the inside without the necessity of moving.

These vaults are manufactured in the form of an ellipse as well as circular. In some cases where the space is limited between parallel tracks the elliptical form is preferred.

The vault lining is built out of creosoted matched material with metallic hermetically sealed sheathing firmly attached to its outward surfaces. Hydrolithic material will adhere to this sheathing with a grip of about 60 pounds to the square inch when it is a month old. The lining, therefore, being used in its entirety as a permanent form to support and shape the hydrolithic material, aids in producing a homogeneous, integral construction of great strength, and accomplishes that at which the scheme especially aims, an assurance of continued soundness and efficiency of the insulation.

Probably the most commonly used vault on railroads is represented in the accompanying illustration and weighs about 2,000 pounds. It is 4½ ft. inside diameter, 6 ft. high and 2 ft. neck opening.

WHAT IS HYDROLITHIC COATING?

Editor Railway Engineering and Maintenance of Way:

Hydrolithic Coating is composed of a specially prepared hydraulic cement and a carefully graded, clean, sharp and hard sand. When set and hard it has all the characteristics of set Portland Cement. Its tensile strength is very similar, its hardness about the same, but unlike Portland Cement, it is absolutely impermeable. In carrying out our work we prefer to apply our coating to interior surfaces, that is, on the inside of the foundation walls, and to the wearing surface of floors. In such positions it is perfectly safe, for its bond to solid forms of

masonry and concrete constructions cannot possibly be broken by water pressure, or for that matter, by any other means. It has, for months and years together prevailed against pressures of 130 pounds, to the square inch, which is equal to over 300 feet head of water, and the older it grows the stronger and tougher it becomes.

It safe to say that, although New York holds a dozen or more concerns that are especially organized to perform waterproofing, yet The Waterproofing Company branch does fully as much work as all the other waterproofers together do. This is not because it is better organized for getting or for performing the work than many rivals for the eastern organization is not yet thirty months old; but primarily because methods and materials are superior to those which all of the others employ. They must still adhere to some one of the many forms of pitch, or of pitch in combination with sheets of felt, or of paper, which in construction are necessarily hidden by auxiliary walls and heavy layers of concrete, which for every other purpose are utterly useless, costly in construction, occupying valuable space, and baffling in the extreme to repairs when leaks occur.

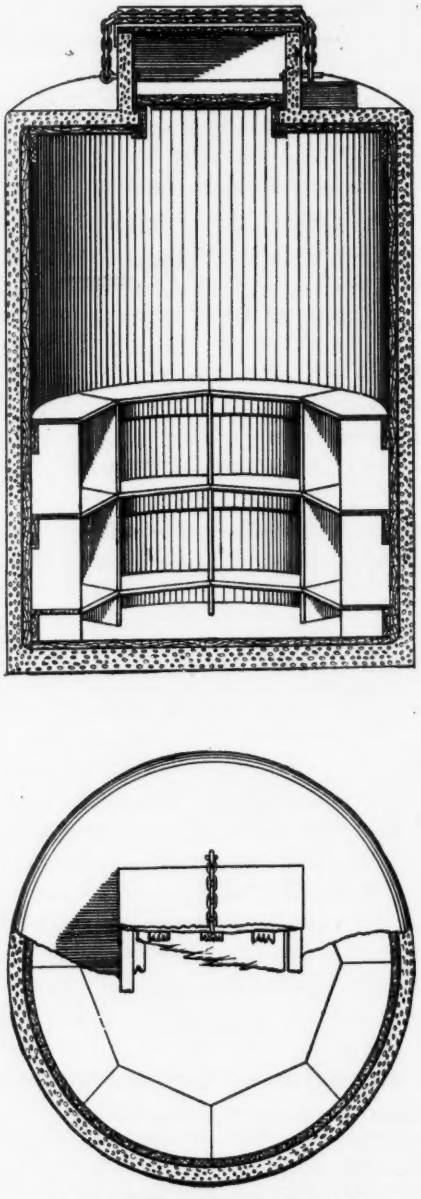
Besides, because these, sometimes called "Membrane" methods, are seldom made perfectly water tight, and are so extremely difficult to repair, when completely buried beneath or behind their retaining constructions, they must be provided with constantly open, under drainage and pumping systems; for it is rare where such schemes for waterproofing are better than checks upon the inflow of water, merely reducing thereby the cost of operating the drain pumps. This is borne out by Edward W. DeKnight, President of the "Hydrex" Company, in his paper read last summer before the American Society for Testing Materials, who said "A very serious mistake is in not properly sloping a flat surface to drains, since water must be kept moving," meaning by his reference to flat surfaces, those upon which the "Membrane" is laid.

On the other hand, Hydrolithic work is capable of application to interior positions, where it is in constant view; instantly accessible if there should be need of it; simply and quickly repaired, should that ever be necessary; occupying no space of computable value; nor needing any open drainage to divert the leakage, for it affords a bottle tight, impermeable shield, with no shrinking, puckering characteristics to make holes in its overlaps, or joints; is impossible of perforation by a careless or accidental dropping of tools, hot rivets, or other missels; and affords a finish in itself, or a base for one, on walls, and a durable, hard wearing finish, capable of sustaining any traffic, on floors.

This system also enables us to build comparatively thin thicknesses of concrete floors. The heaviest floors built for any hydrostatic head, when that alone has to be considered, is 12 inches. Such a thickness of floor we make answer where with the "Membrane" methods the same would have to be loaded with from 3 to 5 feet thicknesses of concrete in order to hold the waterproofing medium in place. In building floors in very watery situations, it is customary to first lay upon the soil a drainage medium of gravel or broken rock, averaging six inches thick, under and in connection with which is a system of boxed drains, consisting of an excavation of 12"x12", filled with 4 inch drain tile and gravel. The sides and bottom of the excavation, if in very soft ground, are supported by inch boards. These boxed drains are run to connect with a sump, to which place all the water under the floor is drained, and from there pumped out during operations; for, while it is unnecessary to relieve the pressure when working on walls, it becomes another matter when floor work is being done. By processes which are patented the manufacturers can concentrate the water at convenient points on the walls, which will allow them to successfully coat all other portions, and to close up the point of concentration after the other areas coated have become hard and strong; but this cannot be done on floors, which, being flat, allow the water to spread everywhere, and we, therefore, have to arrange for a temporary drain beneath the floor, which as soon as the work is finished and seasoned sufficiently, say seven days, is tightly closed and sealed.

The manufacturers of Hydrolithic Coating guarantee all the work they perform, being able, without difficulty to have their own guarantees backed by some good bonding company. The best guarantee, however, is that customers have no fault to find, and that the bonding companies only know of the firm's existence at the time they make application for the bond and pay the premium.

In Pittsburg, during the recent flood, our work allowed its buildings to operate all elevators and electrical machinery in their daily, customary way during the entire period of inundation. We refer particularly to the Union Bank Building, on the corner of Wood street and 4th avenue, which had a 40-foot base-



HYDROLYTHIC CONCRETE STEEL VAULT.

ment clear and untrammeled, while next door to it, the basement of the Commonwealth Trust Company's building, 26 feet deep, held eleven feet of water.

Our work speaks for itself, and we prefer to let it talk for us.

Very truly,

E. J. WINSLOW COMPANY,

Per E. J. Winslow.